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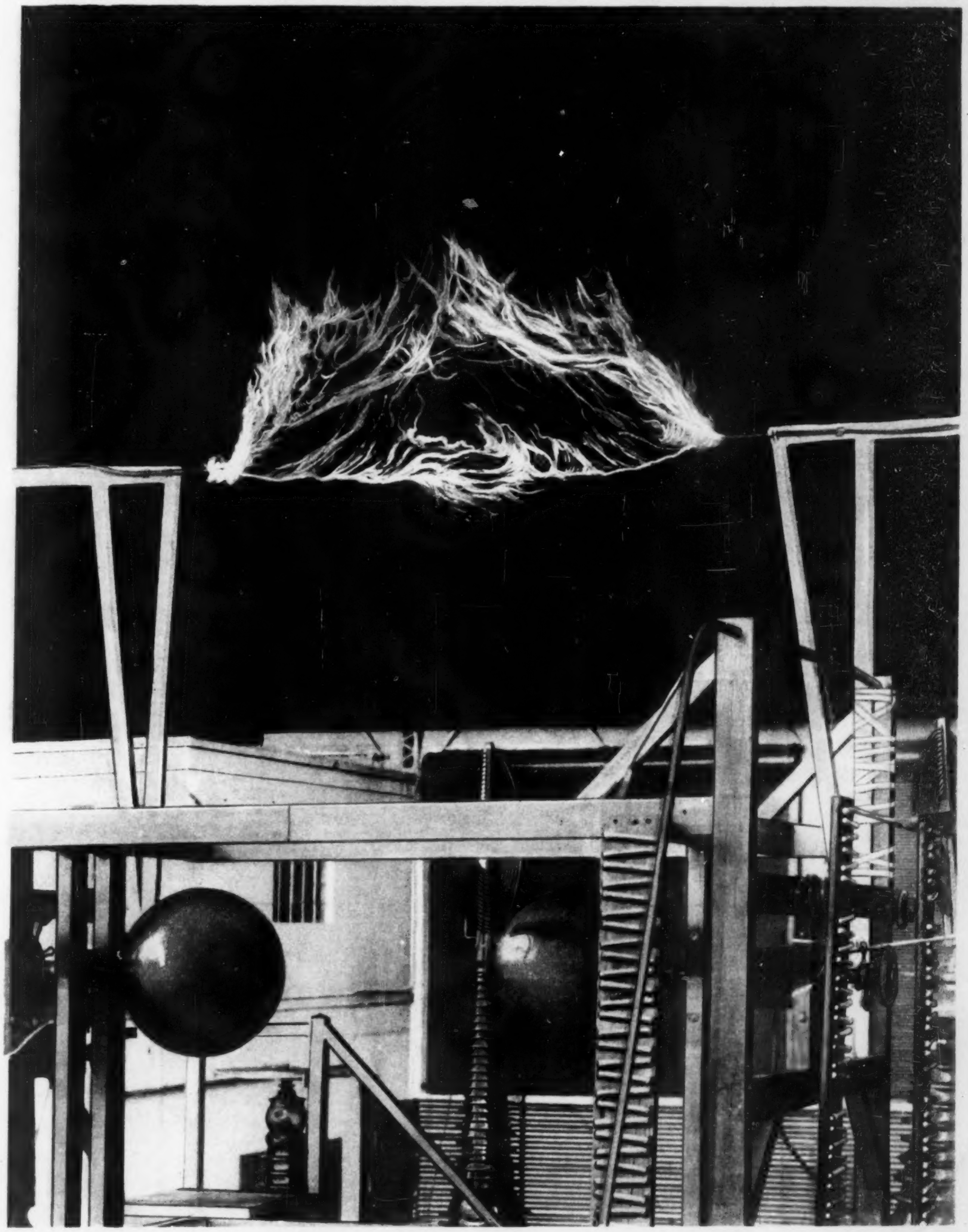
THE AVIATOR'S TELL-TALES

SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS



MAN-MADE LIGHTNING: ONE-MILLION-VOLT SPARK CRASHING ACROSS A NEEDLE GAP.—[See page 268]

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Our Last Appearance as a Weekly

THIS issue marks the last appearance of the SCIENTIFIC AMERICAN as a weekly. On October 20th there will appear the November issue of the new monthly SCIENTIFIC AMERICAN, combining within its many pages the leading features of the former weekly edition and the former monthly edition.

We feel certain that the November issue of the new monthly SCIENTIFIC AMERICAN will more than prove the wisdom of this momentous change. As we have already stated in past announcements, the appearance of our former SUPPLEMENT as a monthly periodical, after appearing as a weekly since 1876, was greeted with such enthusiasm and met such a favorable reception that we were urged to change the SCIENTIFIC AMERICAN to a monthly journal. This we have done—and more; for, as already set forth, we have combined the best features of both the weekly and the monthly editions into one periodical—the new monthly SCIENTIFIC AMERICAN.

Such economies as may be effected in combining these two former periodicals are being turned back to the subscriber: the new yearly subscription price is $4.00 a year, as compared with $6.00 for the former weekly edition and $7.00 for the monthly edition, or a total of $13.00.

Look for the November issue of the new monthly Scientific American, out October 20th

SEVENTY-SEVENTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

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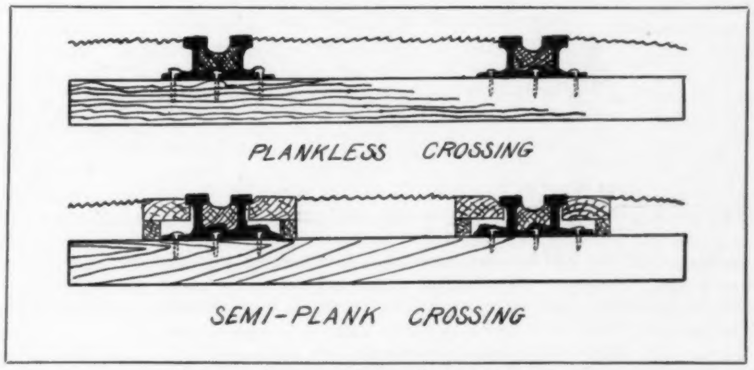
Eliminating the Planked Railway Highway Crossings

By E. R. Mundorff

BECAUSE of the ever-increasing cost of lumber and repairs there is an increasing use of substitutes for planked railway highway crossings. Railway maintenance engineers are not only confronted with the problem of the increasing cost and the scarcity of lumber, but are giving attention to the desirable qualities of substitutes, such as drainage and elimination of rail joints.

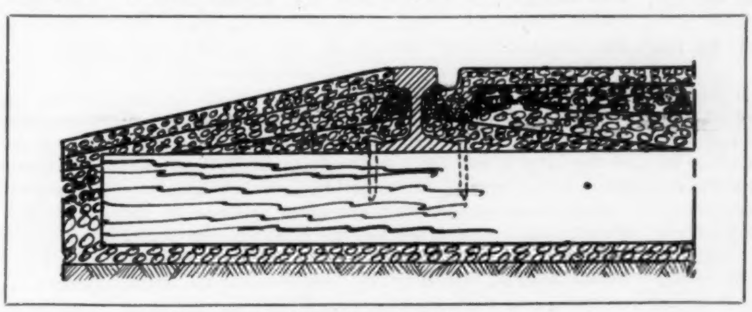
A plankless crossing has been developed on the Lehigh Valley Railroad, the construction of which causes all ballast and dirt to be removed down to the bottom of the tie for the full width of the roadway. Such ties as are not good for at least three years of service are replaced, while tie plates are installed where not already provided. The track is then thoroughly tamped and put in first-class condition for line and surface. In automatic signal or electric circuit territory the rail is insulated on all sides by the application of a penetration asphalt or some similar insulating material. The space between the ties and between the tracks is next filled up to the under side of the ball of the rail with clean stone ballast, well rammed and compacted. A mixture is then made up of an oil binder and a good grade of clean stone screenings containing particles of stone up to 1/4-inch in size, but with the fine dust and dirt screened out. The mixture thus made is spread over the surface of the road, thoroughly rolled or tamped to the level of the top of the rail. No provision is made for a flangeway, the action of the wheels along the rails being depended upon to create and maintain their own flangeway.



New crossings on Jersey Central R. R.

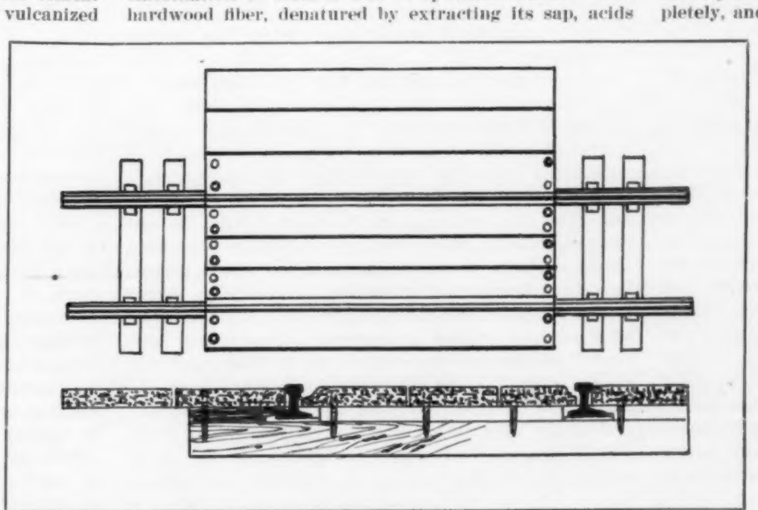
One of the recent developments in the line of plankless crossings is a form of construction which gives a crossing with a good wearing surface and a permanent flangeway, and in addition acts as a seal against the entrance of water to the roadbed. Two classes of material are used, one a bituminous cement or binder, and the other a prepared and vulcanized mixture of which the crossing surface is built. In preparing for an installation of this character all ballast and so forth is removed down to the level of the top of the ties. Rail joints are then eliminated, either by the rearrangement of the rail or by the use of extra long rails, and the track is put in first-class condition as regards ties, line and surface. The ballast is then penetrated with the above mentioned bituminous cement or binder, which is applied as a light fluid which hardens under the action of the air to an elastic solid, completely filling the interstices of the ballast. The tops of the ties and the rails are then swept clean of dirt or dust; and the sides of the rails, the tops of the ties and the surface of the ballast are thickly coated with the filler. The crossing proper is built up of layers of the surfacing material, separated by thick coats of the filler and carried at least four feet from the rail on the approaches, while the center, or parts between the rails, is built up of a tapering layer of the prepared bituconcrete with ballast on this, after which a top dressing of binder is applied, and then about two inches of the surfacing material. This outer material is applied hot and then thoroughly compacted.

The surfacing material is composed of 20 per cent of 3/4-inch-to-dust trap rock, 20 per cent of denatured hardwood fiber mixed with 30 per cent of impalpable mineral dust colloidally suspended in 30 per cent of 99.1 per cent pure bitumen and normal 50 to 55 penetration. The entire mass is then vulcanized by sulphochlorination to form a sort of synthetic rubber. The hardwood fiber, denatured by extracting its sap, acids and cellular tissue, forms the reinforcement of the surfacing material through its ability to absorb the preservative binder which, after vulcanizing, gives a mass strengthened in a manner not unlike that of reinforced concrete. Being somewhat similar to rubber in its elastic quality, this structure is kept "live" by the vibration set up by trains passing over the crossing and thus shows no tendency to break away from the rails.



Section of a bituminous bound crossing

In recent compressive tests on a 12-in. cylinder 6 in. in diameter the filler of the aggregate was found to have more strength than any other part of the aggregates, the trap rock content breaking in two in each test before separating from the filler, while a sample, measuring 3 ft. long, 8 in. wide, by 2 in. thick, supported at the ends under ordinary room temperature, bent double of its own weight before cracking.



Concrete crossing on Pennsylvania R. R.

Seeds and Age

IT is, of course, a well-known fact that the capacity of seeds to germinate tends to decrease with age. In some cases germination capacity falls off very rapidly; in other cases it remains high for a number of years after the seed has been harvested. Among vegetable-garden crops parsnips afford an example of seeds whose germinating capacity soon deteriorates, even so short a period of one year sufficing to reduce the percentage of germination to a relatively low figure. Plants of the cabbage tribe, turnips, etc., retain their germinating capacity longer, but at the end of two or three years it will be found to have become less than it was in the year of harvesting. The seeds of peas and beans suffer less from the effects of keeping, and may give quite good results after three or more years. Needless to say, the power of seeds to retain their capacity to germinate varies not only with the variety, but also with the nature of the harvest and with the conditions under which the seeds are stored. A poor harvest year generally means in this country one in which seed does not ripen thoroughly; that is, does not dry off completely, and such seed generally shows a relatively low initial power of germination and poor "keeping" properties. Conditions of storage also affect the keeping properties of seed. If the air is either uniformly damp or subject to marked alternation of dampness and dryness, the germinating capacity falls off rapidly. That this is the case may be easily understood when it is remembered that seeds are very hygroscopic—that is, readily take up water when exposed to a moist atmosphere. It is, therefore, necessary if for any reason it is desired to keep seeds for a long time, to put them in sealed bottles or jars, and to store them in a cool place. It follows from this that a good general rule is to sow seeds the year after harvesting. This rule, however, is one which admits of numerous exceptions. For instance, some seeds—*e.g.*, Primulas—germinate better if sown before they are fully matured than they do if sown after their fruits have completely ripened.—*Abstract from Gardeners' Chronicle* (London) July 1, 1921.

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Damaged in Transit

ON another page of this issue Mr. H. D. Brown has occasion to refer to the unfortunate fact that a sum sufficiently large in itself to arouse the imagination if it were mentioned by itself, may become altogether insignificant in the presence of a greatly larger quantity. The aggregate savings of the Bureau of Efficiency are by no means a negligible sum of money; but when we place them beside the total of Government expenses for the year, they are so dwarfed that Mr. Brown feels it necessary to say a word in extenuation of what might otherwise be taken as a very poor showing for his Bureau.

Another instance of the same sort comes to our attention this week. The railroads of the United States are just about as much embarrassed financially as is our central government. The sum of $100,000,000 would seem large enough to insure that its wasting would make a dent in any bank roll, and that its saving would improve the financial standing of any Croesus. Yet when it is compared with the figure of five millions that represents the gross operating income of our carriers, it almost seems as though it were not work talking about. Nevertheless it is well worth talking about; where income and outgo strike so close a balance, a hundred million dollars might easily make all the difference between bankruptcy and solvency, even if it does represent only one-half of one per cent on the aggregate capitalization of twenty billions.

The figure of $100,000,000 named above is the amount paid out in 1920 by all our railroads on account of shipments lost or damaged in transit. As a matter of fact, the payments were somewhat more than this but we are dealing with round numbers, and not with the expert accountant's tabulation down to the last penny. Some loss is of course unavoidable in handling such a volume of business as goes over our roads. But the figure of $100,000,000 is susceptible of heavy decrease.

As a matter of fact, on some roads at least, great improvement has been effected. The Pennsylvania system has been as active as any other in the endeavor to reduce this sort of loss. Its executives point out that one reason for the bad showing of recent years has been the general backsliding and loss of morale of the war period and the years immediately following. That they are making real progress in impressing upon their employees the mutual benefits of cutting down the damage account is indicated by the fact that such liabilities for June 1921 show a decrease of practically 50 per cent as compared with June 1920—a figure out of all proportion to the drop in traffic which is admitted to have taken place in this interval.

It is pointed out that so far as the immediate responsibility of the roads is concerned, damage to shipments falls under two heads—rough handling and bad stowing. In the former category there must always be some difference of opinion as to how much of the damage is due to actual unnecessary roughness, and how much to poor packing. The railroad's only salvation here is to educate its agents at receiving points to reject all packages that are not in a condition to withstand the reasonable hazards of the journey for which they are billed. The matter of bad stowing the carrier has within its own control—save for the slight reservation that a collection of less-than-carload lots cannot always be assembled in a car in such a way as to be absolutely tight.

The marked success of the drive upon these two elements of the situation convinces the Pennsylvania heads that other drives on similar lines touching other features of freight claim prevention are desirable in the near future. Perhaps the largest single cause of loss lies in pilfering—if indeed such a word can be used in connection with the highly organized looting of freight cars in big centers like New York and Chicago. Presumably all theft from freight cars on the line and at stations could be prevented, but at a cost that would be prohibitive. The railroads must look upon this as a commercial proposition, and prevent theft only to the degree where the cost of permitting it exceeds the cost of prevention. The whole thing represents a problem whose solution is difficult; but the elimination of the crooks from actual employment by the railroad, and the education of the trainmen and station men to realize that it is to their interest to prevent thieving, would go a long way toward the prevention of large organized looting of the cars.

New Records in Speed and Altitude

ALTHOUGH the advance of commercial aviation is slower than most of us could wish, there is no lack of progress in the laboratory and the experimental workshop. Proof of this is found in the truly astonishing records in the directions of speed and altitude which have just been made, one in France and the other in America. It will be remembered that the last record for speed was set by the French aviator, Lecointe, in the annual race for the Gordon-Bennett Cup, and in some later trials in which he was officially timed as travelling at a speed of over 190 miles per hour, and later, at a speed of 202 miles per hour. A dispatch from Paris states that, in testing out the airplane which he used in the race for the Deutsch Cup, he exceeded his former speed by travelling at a rate of 206½ miles per hour. Just what this means perhaps can best be appreciated when we remember that an express train, when running well above its average speed, is making from 85 to 90 feet per second. So, the next time the milestones are slipping by your Pullman car at the rate of one per minute, you may reflect that Lecointe, in his airplane, was moving approximately three and a half times as fast as that. Yet this does not by any means mark the limit of possible speed for the airman. Further refinement in the plane, particularly in the streamlining of the body, is still possible; and as for the engine, he would be a rash prophet who predicted that even in such efficient motors as the Liberty and the Hispano-Suiza we have reached the limit of mechanical or thermo-dynamic efficiency.

Even more notable than the speed attained by the Frenchman, we are inclined to think, is the really stupendous altitude attained at McCook Field by Lieutenant John A. Macready, the test pilot for the Army, at that justly celebrated center. Taking out the same La Pere biplane which was used by Schroeder when he set a record of 38,180 feet in 1920, Macready climbed until his altimeter registered 41,000 feet. Macready was in the air for 1 hour and 47 minutes, all but the few minutes consumed in his rapid descent being used in steady climbing. He states that at 39,000 feet, ice formed on his oxygen tank; but he pressed on until his gage registered 41,000 feet, when the engine "coughed and died."

It is needless to say that both man and machine were furnished with special equipment for this test, the engine being fitted with the supercharger already described in the SCIENTIFIC AMERICAN, which feeds compressed air to the carburetor at the same pressure as at sea level, and insures a sufficient supply of oxygen. The pilot was clad in the heaviest furs, his suit being electrically heated throughout. Unlike Schroeder, whose eyeballs were frozen and who spent several days in a hospital after his flight, Macready, thanks to the equipment provided, experienced no discomfort whatever and alighted unaided from his machine. Macready's instruments were calibrated by Lieutenant Patterson, Chief of the Technical Data Section of the Field; and the official altitude was given at 40,800 feet.

Consider what this means. At 29,000 feet, or thereabouts, the machine would be level with the top of Mount Everest and, having thus reached the "roof of the world," the machine climbed over two miles above it; so that, when the engine died and Macready pointed the machine down for its swift return to the earth, he was within about 1500 feet of being eight miles above sea level.

Something New Under the Sun

IT must be about three years ago since we were exposed—with no unhappy results, we are glad to say—to the Government-automobile game. A good friend of ours dashed in upon us one fine morning in a state of tremendous excitement. Automobiles which had been purchased by the Government for use in France and which had been left stranded by the sudden cessation of hostilities were lying by the thousand, crated for shipment in slightly knocked-down form, in the railroad stations, shipyards and warehouses of Newark. We gathered the general impression that ordinary pedestrian traffic in the Jersey metropolis was seriously impeded by the accumulation of these cars; that Newark was simply oozing crated automobiles at every pore; that the street cleaning department would have to sweep them into the Morris Canal and open the sewers if something were not done about it at once. They were accordingly to be sold—cleaned out—butchered—practically given away. If we wanted to get in on the good thing, we need only be prepared to produce on instant demand at any time within the next ten days a check for some such sum as $300—the exact amount slips our mind but it was in this general neighborhood. It was going to be a case of instant action; it was not so stated in direct words, but the presumption seemed to be that our telephone might ring at two o'clock in the morning with the glad tidings that now was the moment. The thing had to be handled with a certain amount of finesse, because theoretically the cars were being auctioned; the immediate beneficiaries of the supposed auction had to handle them in lots of a hundred; the buyers of the hundreds were selling in units of ten, through the formation of clubs of individual buyers; our informant was just one remove from the organizer of one of these clubs, who was in direct contact with the source of supply. The tenth man might be secured at an instant, and at that instant all ten would have to produce the money and receive their cars, put them together, and drive off.

We must confess that for a few days we were all a-flutter. After that, each report made the thing look less rosy. With each repetition the tale grew more complicated, and the transaction developed more intermediaries. Finally it attained a parity with the juicy bit of gossip that is retailed with the assurance that the narrator had the information direct from a close friend of the nephew of his employer's sister-in-law's laundress, who overheard a conversation in the street car wherein the talker had explained that a friend of a close acquaintance of the landlord of the boon companion of the proprietor of his favorite restaurant had had a first-hand tip from a man who was in intimate touch with a casual acquaintance of a third cousin of the fiance of the secretary of the person about whom the delicious morsel was told. We eventually reached the conclusion that the pretty tale was wholly a myth.

It now develops that it was anything but a myth to some of the people who took stock in it. The yarn was pretty general throughout the country, the storing place of the cars being varied to suit immediate needs; but as a general proposition the prerequisite was that the intended beneficiary of the offer contribute an initial payment of $25 to meet the cost of an "option" on his car. Why this particular detail was overlooked in our own case we do not know; there certainly was not much nourishment for the perpetrators of the fraud in its absence.

Our reversion to the subject at this time is caused by the fact that after a two years' relapse into somnolence, the same old game is cropping up again in various parts of the country, and "options" on Government automobiles left over from the war are again being peddled at $25 and $30. We have no doubt that the Spanish-prisoner, gold-brick, wire-tapping, green-goods and money-machine swindles have added a permanent member to the family, and one that will take its place in regular rotation with the others. Among the other effects of the war is the addition of a brand new trick to the repertoire of the smooth-tongued gentry. It is an unhappy confidence man who can't find a prospect to whom one of these venerable tricks is old enough to be new; but in this improbable eventuality, he now has one to fall back on that, comparatively speaking, really is new. "The world do move."

Electricity

Shock-Proof Entrance Switch.—Another recent novelty is a shock-proof entrance switch manufactured in various sizes and types, in two and three-pole, and so constructed that it can be enlarged by the use of an additional section or sections which are made to interlock with the original unit. Another feature of this device is that the construction is such that when the door is open, giving access to the fuses, the user is protected from coming in contact with any live or current-carrying parts. For apartment-house work this device eliminates meter cabinets and meter rooms.

An Automatic Switch.—Eliminating waste of current and furnishing light when and where wanted, are two of the functions of a new door switch recently introduced. This door switch provides a convenient means of control for lights in closets, telephone booths, and similar places where the door automatically snaps the switch "on" or "off." The mechanism of the new switch permits no half-way position, when the switch is "on," it is definitely *on*, and vice versa. Another novel switch is the bolt switch for guest rooms in hotels, which is connected in circuit with the usual wall switch. On leaving the room and locking the door the bolt switch cuts off the lights. On entering, the lights will again respond to the operation of the wall switch.

Reduction of Electrical Fires.—According to a recent compilation it appears that out of 138,553 fires which occurred in 1919, only 3,568, or 2.57 per cent, were of an electrical origin. More recent reports state that in Cambridge, Mass., in 1920 there were 780 alarms, with a total fire loss of $431,905. Only one fire was of electrical origin. In Springfield, Mass., there were 1,002 fires, with a total fire loss of $360,115, of which only three were due to electrical causes. In Carthage, Mo., there were 64 fires, only one being caused by defective wiring. It is said that 56 cities and towns have reported no fires of electrical origin during 1920. The total fire loss for these cities and towns was over $1,600,000.

French Airplane Sets.—According to a recent issue of *Radioelectricite*, all models of French airplane receiving sets employ multi-stage vacuum tubes. Two main types were in use during the war, both using a triple stage bulb and differing only in that one had a variable inductance and the other a variable condenser. Both could receive intermittent or sustained waves of from 600 meters to 1000 meters, with an aerial about 260 feet long. The plate current was supplied from a 40-volt storage battery, and the filament current from a 4-volt source. Owing to the intense cold in which the airplanes had to operate at high altitudes, it was necessary to provide some means to keep the lubricating oil from freezing and to warm the pilot's head, hands and feet. In the oil tank an 80-watt heating unit was submerged, while the pilot wore helmet, gloves and overshoes into the fabric of which a resistance wire was woven. The helmet absorbed 16 watts, the pair of gloves 36 watts, and the overshoes 29 watts. If a machine gun was carried on the plane, its oil reservoir too had a heating unit, consuming 70 watts.

Preventing a Burnt-Out Motor.—An American manufacturer of electrical controller devices has recently introduced a novel overload relay which prevents burnt-out motors. The overload relay is a thermal element placed in series with the motor circuit, and the mercury column is a part of the pilot circuit of the magnet switch coil. These relays widen the application of motors of the alternating-current squirrel-cage type because, while giving positive protection against burnt-out troubles, they insure good starting torque by permitting generous starting current for a period of several seconds. Fuse troubles and expense are eliminated; momentary overloads are allowed; but at the first sign of harmful overloading the motor is shut down. The thermal element in question is heated in the same proportion as the motor windings. Excessive current passing for too long a period heats the coil, causes the mercury to boil and the vapor to pass up into a chamber at the top of the tube. This breaks the liquid mercury columns and opens the circuit of the magnet coil. As this coil is de-energized, the contact fingers drop and disconnect the motor from the line. After an interruption the thermal element cools down. The mercury becomes liquid again and drops down into the tube, forming a column through which current to the magnet will pass again after the control button is depressed. So, until the overloads reset themselves the motor cannot be started.

Science

Prof. Gabriel Lippmann, a member of the French Commission to Canada and winner of the 1908 Nobel prize for physics, died aboard the "France" on his way home from Canada.

Daylight Saving Dies in England.—Maintaining an unbroken front in opposition to daylight saving, British farmers defeated the bill that sought to make this measure permanent.

Tin Soldiers Are Neglected.—At the annual meeting of the Toy Manufacturers' Association it developed that there is little call for tin soldiers nowadays, and that mechanical playthings are taking their place.

Bad Acoustics Remedied. — In Macon's new auditorium it was impossible to hear a speaker from the middle of the hall. An inner stage was erected to direct the sound toward the audience; it is said that the dropping of a pin can now be heard anywhere in the building.

A Life Income for Mme. Curie.—The women who raised the money to give Mme. Curie a gram of radium exceeded their goal by $60,000. Another fund of $50,000 is in process of collection. These funds, combined, are to provide her with an adequate laboratory equipment and a life income with which to carry on her researches.

Chateau-Thierry Re-fought.—Louis de Moulin, official war artist of France, has sent us his marvelous diorama, which avails itself of every trick of the lighting art to give us realistic vistas and amazing transformations. One scene shows a crossing of the Marne where Americans hurled back German rear guards; there are many other depictions of American bravery and success.

A Natural Fan.—A dry artesian well in Newark, N. J., has emitted a steady blast of cold dry air for 25 years. The owner, a woman, had this current piped into the house, where it keeps down the temperature in hot weather, dispels dampness, dries the family wash, and dispenses with ice in the refrigerator. The current is continuous and steady, and experts are at a loss to account for its source and action.

New York's Rural Schools.—A child welfare survey discloses the fact that New York State supports 15 one-pupil schools, 52 schools with but two pupils each, 167 with three, 392 with five, and more than 3000 schools not exceeding ten pupils each. These are all small, ill-equipped, inefficient. The report of the surveyors urges consolidation, with free transportation for the children; this would provide better training at less cost.

California's Lofty Mountains.—At least 60 mountains in California rise more than 13,000 feet above sea level, but they stand amid a wealth of mountain scenery so rich and varied that they are not considered sufficiently noteworthy to be named, according to the United States Geological Survey, Department of the Interior. Yet if any one of these unnamed mountain peaks were in the eastern part of the United States it would be visited annually by millions of people. But California has 70 additional mountain peaks more than 13,000 feet high that have been named, or 130 in all, as well as a dozen that rise above 14,000 feet.

Dinner-Pail Calories.—The National Research Council recently called upon fifteen leading scientists; as a committee, these men are to enlist the scientific resources of the country in the investigation of food values; hitherto sporadic movements will be coordinated, and the stenographer's lunch and the laborer's dinner pail are to be brought up to a proper calorie and vitamine content. It is purposed to devote $100,000 annually to this nutritional research, which would be of the highest importance in everyday life, to say nothing of shortage emergencies and war periods. Another problem that would come within the scope of the committee is that of utilizing for animals waste material unfit for human consumption.

Aeronautics

Between Reval and Stockholm.—The Svenska Lufttrafik has established an airplane service between Stockholm and Reval. Two trips per week each way are being made, the trip taking three hours. Mail from Sweden and passengers both ways will be carried, there being accommodations for five passengers on each trip. A subsidy for carrying mails is received from the Swedish Government, and it is expected that the Esthonian Government will also grant a subsidy to provide for carrying mail from Esthonia to Sweden.

More Light on the "ZR-2". — Commenting on the fatal ending of the "ZR-2" dirigible, the British periodical, *Flight*, has the following to say: "This airship was designed to have a high ceiling—27,000 feet—and to this end her construction was kept as light as was considered consistent with adequate strength. In order to ensure lightness, several departures from standard practice were incorporated, among which the employment of fewer gas bags. This would naturally result in a greater portion of the hull being affected in the case of over- or under-filling of one bag, while the girder length between frames would be increased.

A New 1000-Horsepower Engine.—The tendency in aviation appears to be toward larger engines on the one hand, especially for the large passenger-carrying planes, and toward smaller engines for the single-seaters. Word now comes to the effect that the Engineering Division, McCook Field, has completed preliminary design of a 1000-horsepower 18-cylinder engine. The design is being further developed on the basis of 1000-horsepower at 1400 r.p.m. direct drive, this speed ensuring great reliability and being favorable to high propeller efficiency in connection with a large power output. A cylinder of the proposed design has been constructed and tested with very satisfactory results. It is of the four-valve type, with welded steel jackets.

An Altitude Record. — On September 28th last Lieut. John A. Macready, test pilot at McCook Field, Dayton, Ohio, flew a La Pere biplane to a height of 41,000 feet, according to his barometer reading, but the true height after the instrument was calibrated stands at 40,800 feet, thus establishing a new world's record. The previous record was held by Capt. Schroeder who, in the same type of plane, flew to an altitude of 33,114 feet. The La Pere plane used by Macready is equipped with a supercharger recently invented by Dr. S. A. Maus, which takes care of the rarefied air at high altitudes and also takes care of changes in mixture and keeps the radiator warm. A new propeller of somewhat larger size than usual was also employed in the record-breaking flight.

Control in Circling Flight.—An investigation was undertaken by the National Advisory Committee for Aeronautics at the Langley Memorial Aeronautical Laboratory some time ago for the purpose of developing instruments that would record the forces and positions of all three controls, and to obtain data on the behavior of an airplane in turns. All the work was done on a standard rigged "JN4H". It was found that the airplane was longitudinally unstable and nose-heavy; that it was laterally unstable, probably due to too little dihedral; and that it was directionally unstable, due to insufficient fin area, this last being very serious, for in case of loss of rudder control the airplane immediately whips into a spin from which there is no way of getting it out. On the other hand, it was found possible to fly quite satisfactorily with the rudder locked, and safely, though not so well, with the ailerons locked.

British Planes with Little Planes Upon Them.—Experiments with a remarkable type of battleplane which carries its own scout machine poised at the tip of one of its wings have been carried out at Farnborough, England. Two big bombing planes have been flying over Aldershot with a diminutive airplane fixed to the upper wing. So far it is understood that the tests have been successful. The parent machines have traveled at their usual pace, although the engine of the scout machine was kept running so that it was ready to dive off at a minute's notice to protect the larger and heavier craft. The automatic releasing apparatus is constructed on ingenious lines, we learn from *Aerial Age Weekly*. An expert pilot is carried by the bombing plane and as soon as his services are required he climbs through the top wing and takes his seat in the scout plane. By pressing a trigger he frees the smaller machine which at once glides along the battleplane wing and dives off.

THIS issue marks the last appearance of the SCIENTIFIC AMERICAN as a weekly. On October 20th there will appear the November issue of the new monthly SCIENTIFIC AMERICAN, which will combine the leading characteristics of both our former weekly and monthly editions within its many pages.

Man-Made Lightning

Experiments with One-Million-Volt Transmission That Point the Way to Future Power Distribution

THE age of artificial lightning appears to be close at hand, not as a mere stage effect but as a practical means of distributing electric power over nation-wide areas. Only a few weeks back the press announced the culmination of a series of tests aiming to raise commercial currents to one-millionth-volt potential and then transmit that lightning-like current over a properly insulated transmission line. The final experiments would seem to indicate that such high potentials can be generated and handled, but there remains a vast amount of engineering work before we can begin to raise the potential of our electric power lines from the present high mark, 220,000 volts, to still higher potentials.

One million volts is nearly five times the highest voltage ever before placed on a transmission line. The 220,000-volt line referred to is that of the Southern California Edison Company, now in course of construction. One-million-volt potential is one-fiftieth of the voltage that a flash of lightning is estimated to represent, according to Dr. Charles P. Steinmetz, the well-known electrical engineer; so, we are slowly coming to use in our everyday life the counterpart of what has heretofore been considered a great destroyer of life and property.

The remarkable high-voltage tests in which one-million-volt potential was reached took place at the high-voltage laboratory of the General Electric Company at Pittsfield, Mass. The most important point in connection with these tests is the adding of new and valuable knowledge to the long and constant study of high-voltage phenomena, upon which calculations can be based for the extension of long-distance transmission. It is also interesting to note that these experiments have been carried out by specialists in electrical transmission—men who have seen the distribution of electric current on a long-distance scale begin with 15,000 volts in 1891, and culminate with the erection of the 220,000-volt line in southern California.

The object of high voltages in electrical transmission is pretty generally understood today. The average layman appreciates the fact that the flow of electricity through a conductor is very much like that of water through a pipe. The higher the pressure or volts, the less becomes the resistance offered to the current by the conductor. Hence in building a transmission line the engineer is confronted by these alternatives: Either to use a heavier conductor so as to have the lowest possible resistance, in which case a lower voltage can be employed, or use a higher voltage and smaller conductor, but make ample provision for the increased insulation necessary to take care of the higher potential. Of course, conductors rapidly rise in cost for every square mil that is added to the cross section. Insulation is less expensive than metal, hence higher voltages are resorted to. Furthermore, since there must be a line loss in all electrical transmission, it follows that the generation of electric power at one remote spot may not be commercially practical for the reason that its transmission would involve too long a line with too great a loss, according to our present standards. But with a vast increase in potential the practical range of electrical distribution goes up by leaps and bounds; so that water power that is today considered of little or no commercial value because of its extreme remoteness may yet be used tomorrow in our workaday world.

One million volts is far beyond the comprehension of the ordinary layman, states Dr. Steinmetz. It is interesting to recall how rapidly high voltage development in this country has progressed. It is about forty years since Edison first transmitted electricity at constant voltage. He used 110 volts and later 220 volts. At this pressure, electricity can be sent economically for about one mile. In the intervening forty years, voltages have increased until now we are actually using 220,000 volts, a pressure just a thousand times greater than that which was considered the limit of safe pressure when Edison began his experiments.

Now we are thinking of one million volts. While electricity, as these tests show, can undoubtedly be transmitted in large bulk if so desired, for possibly thousands of miles, it is possible that the millions of horsepower available at various points, such as Niagara Falls and the St. Lawrence River, would find a market and be consumed within a few hundred miles of their source.

The big problem in transmitting this extreme potential is to confine the current to the wires. The loss of a part of this current through leakage into the surrounding air is an ever-present possibility. This leakage takes place in the form of the corona—that effect which forms a crown of colored, luminous haze about conductors. The recent million-volt experiments have brought out the interesting fact that wires four inches or more in diameter would—and actually did—carry such high potentials without serious loss. Should we ever come to million-volt transmission, it is likely that hollow tubes would be found more economical and just as effective. It would also be found essential to build the high-tension transmission lines for carrying one-million volts on high towers, in order to keep the conductors out of the reach of any danger to human life.

Aside from the transmission line proper, there are many problems in the way of transforming apparatus and switching gear. In the experiments the original or primary current was 2,000 volts at 60 cycles. This current was stepped by passing through one transformer after another—a cascade arrangement.

Our cover illustration has been prepared from an actual photograph, showing virtually a million-volt current jumping an air gap between needle points. In fact, high voltage measurements are generally taken by means of a needle gap, since there is a very definite ratio between the sparking distance between needle points and the potential employed. The illustrations on this page show the needle gap and below it the huge sphere gap, with a man standing between the sphere electrodes so as to furnish a comparison for size, as well as a flash-over test on a string insulator, using about 600,000 volts.

Left: The sphere gap used in the 1,000,000-volt tests. The needle gap, employed in measuring high potentials, is shown directly above, the electrodes being held by the V-shaped supports. *Right:* Some idea of the insulation problems in connection with extreme potentials may be gathered from this view. This is a high-voltage insulator test at about 600,000 volts, showing a flash-over on a string insulator and from wire to tower simultaneously, arcing distance being over six feet

Details of the million-volt transmission tests

A Fuel Comparison

By H. F. Crafts

IN approximating the intrinsic value of the farm tractor, the larger item in the account is that of superior power in action.

Among the lesser items is the economy of fuel. This may not appear so large until we strike a comparison between the cost of tractor fuel and horse fuel.

Some figures which I have recently obtained from a California farm tractor expert afford a very convenient basis for making this comparison.

The problem consists in approximating the fuel cost of 100,000 horse-power hours, as produced on one hand by the horse, and on the other by the farm tractor.

Let us take the horse side of the question first:

According to this expert, it would require 301 tons of hay and 10,625 bushels of grain to do the job.

Taking the average price of hay on the Pacific Coast at the present time to be $20 a ton, the hay item in this sum in arithmetic would amount to $6,020. Taking oats at $1.20 per bushel, the grain items would amount to $12,750; total, $18,770.

Now let us figure the tractor side of the problem:

It would require 11,250 gallons of distillate and 750 gallons of oil to accomplish the 100,000 horsepower hours by the tractor.

There is also a question of 125 pounds of cup-grease, but this is such a small item we will leave it out.

Distillate in Oakland today costs the consumer 14½ cents per gallon; 11,250 gallons would cost $1631.25.

Oil costs about $1.20 per gallon; 750 gallons would cost $900; total $2531.25.

Difference in favor of the farm tractor, $16,238.75.

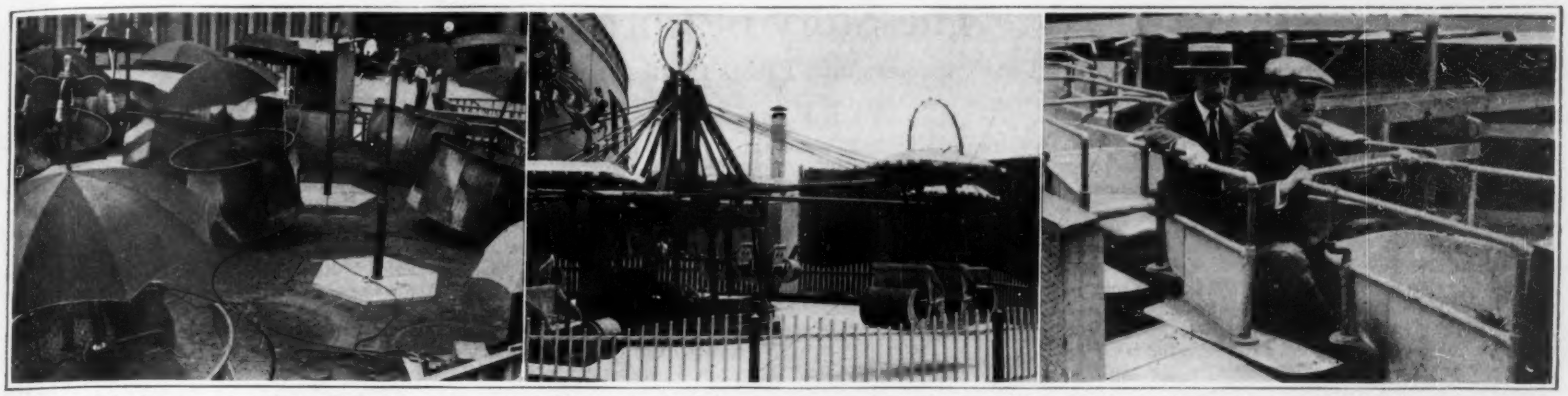
This seems almost incredible, but it is undoubtedly true. Well, here is still another interesting phase of the question.

The hay and the grain fed to those horses could very easily be replaced by straight human food products and if the horse were to be eliminated this food could be saved and added to the world's food supply.

This same tractor expert informs me that 40 horses will eat the produce of 200 acres of land per annum, or in the aggregate the horses of the United States require for feed the produce of 120,000,000 acres of land or enough to support not less than 40,000,000 people.

Eliminate the horse population of the United States at a single stroke and turn the equivalent of their subsistence over for human consumption and our aggregate food supply would be increased 40 per cent.

But this is not all: The farm tractor's fuel supply does not come from our soil, but from beneath it, and consists of no substance that could be possibly made available as human food. And these reflections clear the atmosphere, and permit the monumental superiority of machine power over animal power to stand out in clear and unclouded effulgence; and to reveal the magnitude of the vast burden that is destined to be lifted from the shoulders of the food-producers of the world.



Left: The disks that carry these chairs roll about at random over the floor, tipping the chairs now one way and now another, colliding, and in general giving the occupants a hilariously rough time. *Center:* The cars, suspended at the end of these long arms, go around in a circle and at the same time pitch up and down as though riding the waves. The effect is highly edifying upon the passengers. *Right:* The short cars of the roller coaster, which make possible some evolutions that would have been out of the question with the usual longer cars

Some of the joy-riding stunts at the new amusement park in Venice, Cal.

Some New Mechanical Amusement Devices

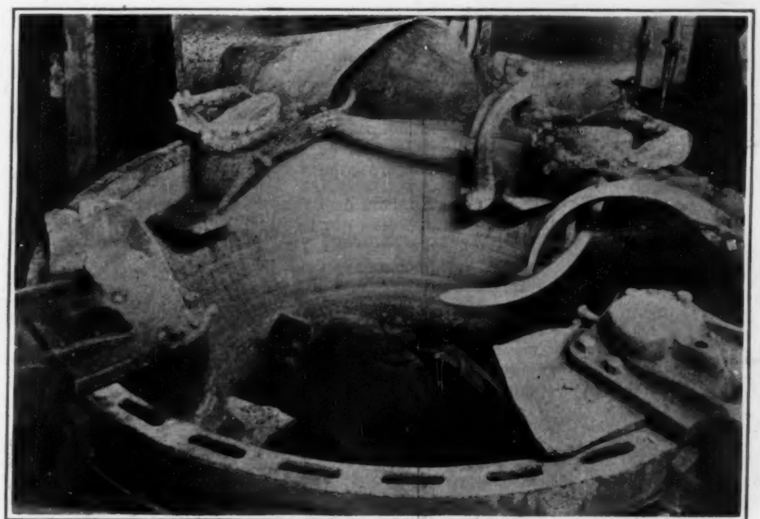
THE recent announcement of a Venice, Cal., amusement promoter to the effect that his new pier would have all new pleasure devices was not taken particularly seriously until the place in question was thrown open to the public. Then, for the first time, the amusement seekers realized that he had made good his promise and that the pier housed one of the most startling collections of mechanically ingenious contrivances yet built.

While there are literally dozens of new mechanical devices for the amusement and "thrilling" of the pleasure-seekers, a description of four or five of the most ingenious will serve to give a good idea of the resourcefulness of the men who designed them.

The first concession one encounters on the new pier looks at first glance to be a number of round wicker chairs on a rough sea. As a matter of fact, the floor consists of a number of disks, eight or ten feet in diameter, each one of which revolves independently of all the others.

The chairs are mounted on an iron pivot. They are each loose. When the customers are seated in their little chairs, the disks start to revolve. As the chairs roll about, they encounter the various disks, first one going one way; then one going the other way. They bump together, bounce around, and otherwise travel in unexpected directions, while the passenger experiences a sensation similar to that of a stunt aviator.

A device known as the "Dodge-Em" is a clever piece of electrical and mechanical work. Small cars, fitted with steering wheels, are placed on a polished hardwood floor. A trolley connects each little car with an electrically-charged mesh and screening overhead. The car is mounted on casters. When all the cars are occupied, the current is turned on and the passengers endeavor to ride around the floor without colliding with other cars. As the steering wheel operates only the trolley, and as the wheels are independent of each other, the steering is only relative and it requires extreme ability to dodge the other fellow's car. A foot pedal is provided to control the car and stop it when necessary. Collisions occur every few seconds, but as there is a heavy iron bumper around the base of each car, no damage is done and the riders get lots of fun out of the thing.



The centrifugal concrete mixer

The time-honored roller coaster has been revolutionized into a thing known as the "Bobs," in which the usual cars have been replaced by a sort of series of iron baskets, mounted on wheels. These baskets are connected together into trains, but because of their independence and smallness, they operate like a bicycle chain and permit the trains to take extremely sharp turns and steep bumps with safety. Hence the "Bobs" provide thrills that the roller coaster with its long

(*Continued on page 278*)

A Centrifugal Concrete Mixer

THE open-pot type of container used in preparing concrete for laboratory and commercial purposes is subject to competition if exhaustive tests now being made by the Cement Section of the National Bureau of Standards establish the merits of a new centrifugal mixer, designed by a New York City engineer. The newly-designed apparatus for mixing concrete is one-half yard capacity and consists of a horizontal bowl which is rotated about a vertical axis at 70 to 80 r. p. m.

In actual use, the contents of the bowl are thrust outward and upward by the centrifugal action, and are deflected back in streams to the center of the container by four fixed deflectors affixed to the stationary frame. To unload the mixer, the operator slightly elevates one of the deflectors, the mixture proceeding to flow over the rim of the bowl into a hopper or chute. Complete mixing of a batch of material, under favorable environments, is insured in 15 to 30 seconds.

Comparative tests conducted by the Bureau of Standards to determine the relative merits of the open-pot container and the centrifugal mixer indicate that the grinding action of the latter produces such a fine aggregate that stiffer consistencies were obtainable. The increase of fine material is such as to require from 5 to 10 per cent more water to insure the same degree of flowability as that in a similar batch subjected to the open-pot or laboratory mixer.

Results of government tests show that if like batches of aggregate cement and water are mixed in the same proportions in the two types of containers, the strength of the concrete yielded by the centrifugal mixer is 20 per cent higher than that amalgamated in the open-pot mixer. However, this superior strength is attained at a sacrifice of flowability, which detracts from the seeming superiority of the centrifugal mixer in comparative tests. By adjusting the water content with the view of

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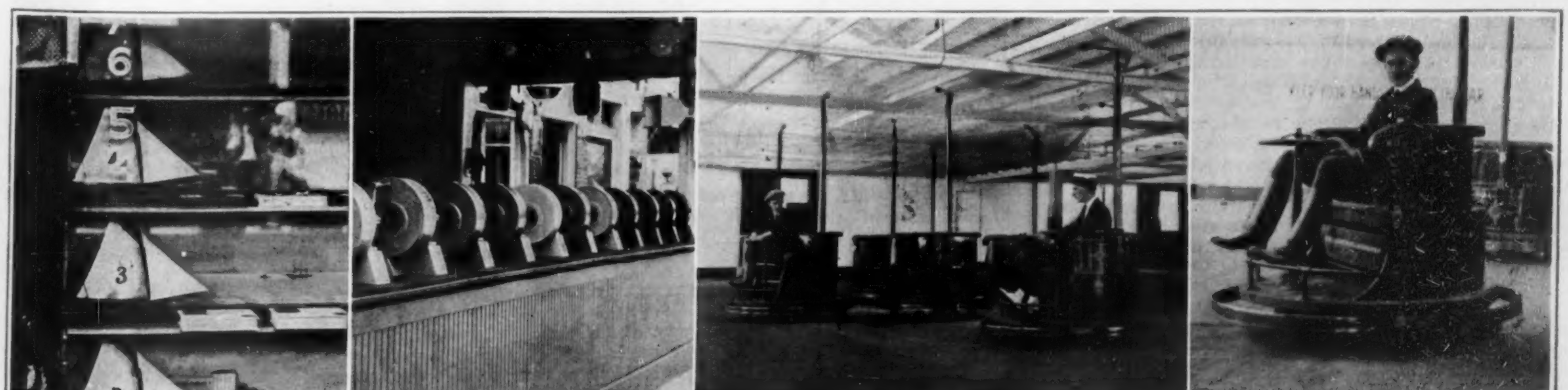


Left: The yacht race, in which the competing craft are driven over their enclosed courses by air pumps, manned by the contestants. *Left center:* The row of wind machines at which the yacht-racers labor. *Right center:* General view of the "Dodge-Em", the object of which is to steer the highly unmanageable car about the floor without collision. *Right:* Close-up of one of the "Dodge-Em" cars

Two more novel mechanical devices for whiling away the idle hours

The Story of Cork

Where the Raw Material for Stoppers and Floats Comes from, and How It Is Obtained

By J. F. Springer

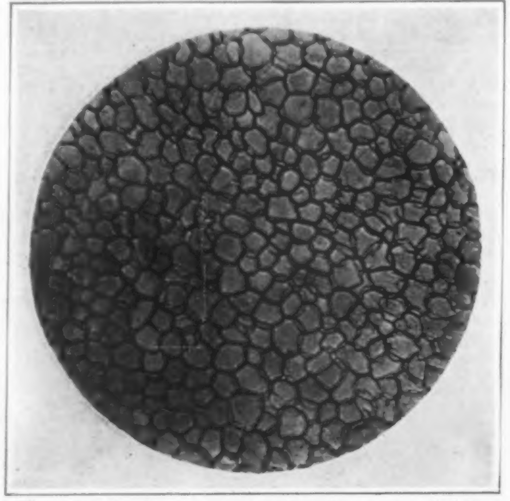
EVERYBODY knows what cork is, and is more or less acquainted with its use. But comparatively few have clear ideas as to the parts of the world where it is produced and the precise way in which it grows. In Portugal, Spain, southern France and generally the lands lying in and near the western Mediterranean cork is produced, on the largest scale in Portugal. It is a product of a species or of two species of the oak (*quercus suber, quercus occidentalis*). Nobody seems to know the origin or the essential meaning of *suber*. Some guesses have been made, but nothing substantial has been ascertained. Similarly, the English word *cork* seems to be of uncertain meaning and derivation. But there is perhaps a plausible connection at least with the Spanish *corcho* (cork) and the Latin *cortex* (bark). It has been suggested that it is a corruption of *quercus*. However all this may be, the thing itself is definite.

The cork tree grows to the height of 20 to 60 feet and the bole attains diameters up to 4 feet. But this diameter has certainly been exceeded. In 1877, a tree in a cork forest in the province of Gerona in northeastern Spain measured 16 feet 3 inches in circumference. This means a diameter of 5 feet 2 inches. The height up the trunk was about 15¾ feet. This tree was estimated as having at the time an age of 150 or 200 years. The foliage of the cork tree consists of small evergreen leaves, spongy and velvety to the touch. The edge is of the saw-tooth type and the appearance of the leaf is glossy. A representative leaf measures, say 1½ inches long by ½ inch broad. The roots are robust and spreading, and are not always completely buried in the soil. The blossoms come out in May and the acorns ripen in the fall or winter. The latter are of importance, since when fed to swine they are converted into a high quality of pork, particularly ham. Spanish mountain hams have what is called a "piquant" flavor.

A notable thing about cork trees is that they are apt to require more shade for their roots than their own foliage supplies, if good harvests of cork are desired. One mode of meeting the requirements of the case is to manage the new grove so that when the trees are about twenty-five years old the branches of the trees will touch one another and the general area be fairly covered. Another method proceeds by the introduction of trees of other kinds in the intervening spaces—such trees as, for example, the elm, the ash, the pine. The function of these trees is to supply shade and keep the ground rich in vegetable matter. Cork trees, like milch cows, may be overfed, with somewhat similar results. That is, if the ground becomes especially rich, the quality of the cork falls off. There is, however, a goodly amount. With poor soil, the amount is less, but the quality is good. What is desired is a combination of production and high quality.

The cork of commerce is the exterior shell of bark. This is stripped from the trunk of the tree and sometimes from the larger branches. The young trees are left to grow in the natural way until they have reached a fair age and a moderate size. Spanish law requires that the circumference be 16 inches, which corresponds to a diameter of about 5 inches. The tree will then be about 20 years old. The product of the first stripping is not of the best quality. However, the tree at once proceeds to renew the covering and produces one of a finer texture. This is not removed for eight or ten years. The bark is perhaps best regarded as, for the most part, dead tissue. The real, living skin of the tree is the *phellogen*. It is the seat of growth of both tree and bark. Each year it produces two layers of cells, one for the tree and one for the outer shell. In the course of the eight or ten years after the first stripping, the thickness will have become sufficiently great to warrant a second stripping. This cork will be of better quality than that first produced, the texture being finer. This process of stripping again after an interval of about 9 years is the customary practice, it appears, of the leading district. With the third stripping, at the age of, say, 40 years, the tree properly begins its output of high-grade cork. It continues productive for upward of a century. An authority upon cork growing in Algeria lays down the rule that the new cork should not be stripped off until it has become 0.8 inch thick. The first cork produced by a tree (*corcho-bornio*) has but little value, commercially, because of its coarseness, roughness and density. The second barking (*pelas*), while not so good as subsequent yields, is sufficiently valuable to become an article of commerce.

A peculiar circumstance is the fact that the product of the larger branches is often better than that of the bole. In actual practice cork is stripped from the tree at very different thicknesses, ranging, say, from ½ to 2¾ inches. Naturally, the amount of cork produced by a tree will vary with the tree, its age, and the length of time the bark has been accumulating. Forty-four to 165 pounds per tree is a fair range.



The structural appearance of cork as revealed by the microscope

The stripping, as one might easily imagine, is not a matter for a careless workman nor for unsuitable tools. The bark itself must be carefully preserved in order not to lessen its value commercially. The well-being of the cork tree must be cared for adequately; otherwise the source of profit may be very seriously damaged.

The inner skin, that is, the true skin, must be preserved. If it is broken through at any point, there will never again be any growth at this spot. If the true skin is much damaged, the very life of the tree may be imperilled. Of course, after a stripping, this true skin will be exposed for a time. For this reason, if a sirocco is raging, the trees should not be stripped, as exposure at this time might very well mean an excessive drying of the skin leading to future absence of cork.

It has been proposed to protect the true skin with the newly removed cork. This is known as the Capgrand-Mothe system. It proceeds by arranging the separated bark around the tree; but it does not seem to have been widely adopted among large producers.

EVERYBODY knows what cork looks like and is more or less acquainted with its use. Comparatively few have any clear idea as to the parts of the world where it is produced or the precise fashion in which it grows. That it is in a general way a wood or a wood product most of us probably realize; just what relation the crop bears to the tree from which it comes, how it is harvested, what state the harvest leaves the tree in, and similar questions, must be a dark enough secret to the majority of those who apply the corkscrew to the neck of a bottle or wrestle with unsatisfactory substitutes like the pen-knife or the skewer. In this article Mr. Springer gives us a comprehensive account covering all these points of puzzlement, and more besides.—THE EDITOR.

The Spanish method of stripping depends upon a long-handled hatchet. Crescent-shaped saws have also been employed, especially in Algeria. Whatever the tool, the workman makes two cuts all round the tree, one above and the other near the ground. The bark is cut clear through. Then these enveloping cuts are followed by one or two longitudinal ones. Advantage may be taken of natural crevices or cracks in the bark. After the vertical cuts are made, the workman, if he uses the hatchet, inserts the wedge-shaped handle and pries off the bark. Good judgment and some skill are required. The work is done in mid-summer. The exterior surface is rough and woody. This condition is due to exposure to the weather. The crude raw material is boiled, whereupon the useless rough layer may be easily scraped off. The loss in weight due to this scraping operation will run up to the neighborhood of 20 per cent. The boiling procedure results in the elimination of tannic acid. The volume of the cork is increased and also the elasticity. In short, after boiling, the cork is comparatively soft and pliable and may in consequence be flattened out and packed in layers.

The cork forests are likely to be in rather inaccessible situations—in the mountains and hills. It is necessary therefore to get the crop ready for transportation. A rough sorting for quality and thickness is gone through with, and the various classes made up into rough bundles and put upon the backs of the burros. As the cork does not weigh much, the animal is loaded from head to tail, or nearly so, in order to provide for him a suitable load. In the principal districts, there may be a line of 30 or 40 or even 100 of such loaded burros in a single "train." They are on their way to the railway, and constitute a very appropriate means of accomplishing this first instalment of the necessary transportation, as they are competent to thread their way over narrow and precipitous paths in the mountains and hills and to pass through the alley-like streets of the intervening villages.

Once at the railway, the transportation becomes a simple, everyday affair. The destinations include seaports of Portugal and Spain. Seville, in Spain, is perhaps the principal receiver of raw cork. Here on the banks of the Guadalquivir the cork is in part manufactured and in part stored and shipped. During the latter part of the summer, the street scenes are pretty well dependent upon cork in some way. Hundreds of burros with their loads will be filling the streets as they pass on their way to this or that warehouse or factory. If the cork is to be shipped, the bales are opened up and the edges of the bark trimmed. The cork is then regraded for quality and thickness. Afterward, it is packed into bundles or bales. A usual method of packing requires that large flat pieces (planks or tables) be put at the bottom and that the smaller pieces be built up into a mass above, and that finally a second quota of big, flat fellows be put on top. The whole bundle is then compressed and bound. Steel hoops or wires serve as the binding material, just as with us in baling hay and cotton. After the baling, the cork is ready for shipment to all parts of the globe. Cork for manufacture in America is naturally received at Atlantic ports, particularly at Philadelphia, New York and Baltimore. Arrived at such ports, it may or may not require further shipment by railroad to the manufacturing plant.

There is a wonderful variety of uses to which cork is put. But the requirements of these uses vary greatly; so that it is very necessary to grade the raw product with especial reference to the precise use to which it is to be put. The raw material has already had two gradings. But these are entirely inadequate. Modern manufacturing requires sorting that will produce in the neighborhood of 150 different grades. The foreign grades number no more than about twenty-five. Some of the American gradings, for example, are exceedingly close; so close, indeed, that when made the inexpert are apt to see no difference. But success in manufacturing turns on distinguishing differences, some of them very minute.

In making corks for bottles and the like, the length of the cork corresponds with the original vertical dimension of the cork bark when still on the tree. In consequence of this condition, the thickness of the layer determines the maximum diameter of the stopper that can be made from it. The first operation upon the raw material is its subjection to a warm vapor bath. This has the effect of greatly increasing the flexibility. It also adds something to the bulk. Corkwood is hard to cut, as the reader, if skeptical, may determine very readily by actual trial with a penknife. Its softness

and elasticity create difficulty. At the big factory, the cutting of the layers into transverse strips is done by a rapidly rotating steel knife of circular form. It has an edge like a razor and succeeds where a more slowly moving knife would fail. The strips are then operated on by a tubular punch rotating like a machine twist-drill. This work is done with the greatest rapidity. The stoppers as they come from this operation are cylindrical. If tapered corks are wanted a supplementary operation is carried out with another rapidly rotating circular knife. But the foregoing accounts for only some of the corks. Many stoppers are made along the lines of the old Spanish method. That is, after the strips have been cut and the outer rough crust has been taken off, the strips are cut into box-like pieces—parallelopipeds. From these rectangular blocks the stoppers are fashioned. Often this fashioning is done by hand methods. The making of stoppers is very wasteful; so much so that only about 35 per cent of the original weight of raw corkwood remains in the finished article. Hence the efforts to use the 65 per cent. Composition cork is made from waste with the aid of proper binding substance. This composite material then becomes basic for a whole line of manufactured products—table mats, fishing line floats, polishing wheels, etc. A special material for heat insulation is also made from the waste—that is, in this case, from granulated material.

The U. S. Collection of Animal Parasites

By S. R. Winters

IF the Bureau of Animal Industry of the United States Department of Agriculture were abolished—a far-fetched supposition, to be sure—its laboratory collection of specimens of parasites which infest domestic live stock would automatically become the property of the National Museum. So valuable and comprehensive is this cumulative knowledge relating to pests which prey upon horses, cattle, sheep, swine, poultry and other animals, probably the biggest collection of parasites in the world, that specific Congressional legislation safeguards this massed information for posterity.

The assembling of parasites, which work was initiated by Dr. Cooper Curtice in the late eighties, and formally arranged into logical groupings by Dr. C. W. Stiles and Dr. A. Hassell, has attained such enormous proportions that in excess of 10,000 ledger pages have been utilized for entries. Two books, embodying 5000 accessions each, have been filled with notations on individual or groups of parasites, and the third ledger account is being written. The specimens, upon being consigned to the Zoological Division of the Bureau of Animal Industry, are bottled in a preserving fluid and the label reflecting the contents is encased inside of the container to avoid blurring or effacement. The data incorporated in the big daybooks of the laboratory include the technical name of the worm or parasitic insect, date of collection, by whom collected, and the location of the specimen when taken from its host.

The flukes, tapeworms, roundworms, parasitic insects, ticks and mites are predominant in the world's largest collection of live stock enemies. The bulk of the vast assembly of parasites were formerly unbidden guests of man, horse, mule, donkey, cow, sheep, goat, swine, dog, cat and poultry. The Zoological Park of Washington, D. C., is likewise a contributor to the collection, wild animals yielding a varied assortment of preying insects. Foreign countries make consignments of their undesirable guests, soliciting the Department of Agriculture to identify these parasites and prescribe control methods. The investigations primarily, however, concern themselves with enemies of the live stock of American farmers, the massed knowledge lending itself readily to application afield wherever parasites infest domestic animals.

Augmenting the 10,000 bottled specimens of animal parasites is the largest card catalogue and index system ever corraled on the subject. It is a monument to the efforts of Dr. A. Hassell and his associates for an unbroken period of 30 years. From 1902 to 1912 there was published 2766 pages of authors' catalogue, and the unpublished material which has since accumulated will swell the pages of this volume. The information on the tapeworm extends through a book of 467 pages, printed in 1912. A catalogue compiled by C. W. Stiles and A. Hassell during 1920 consumes 886 pages, while knowledge relating to flukes embrace 401 pages, appearing in book form in 1908.

Quite logically, the American live stock grower and farmer inquires as to the serviceableness of this profound knowledge when bound between the lids of a book, which has quarters in a laboratory in Washington, D. C. The Zoological Division of the Bureau of Animal Industry would answer in this wise: What has been done the world over in eradicating parasites from domestic animals has been assembled in compact form, the information being quickly available to farmers, veterinarians, physicians and scientists. The knowledge can be speedily given practical application. Take a glance into the mail of the Zoological Division and note the variety of inquiries which draft upon this fund of information!

The United States Army submits a consignment of smoked herrings infested with roundworms; a citizen of North Dakota desires pictures of parasites to illustrate a book; a farmer in Florida seeks a remedy to expel kidney worms from swine; a resident of Pennsylvania submits a group of lung worms from sheep for examination; a rural dweller in Illinois consigns to the laboratory for analysis some earth worms found in the drinking water; a commercial enterprise in Maryland solicits expert advice concerning a louse powder; an officer in Texas sends to the Zoological Division a collection of ticks from a goat; a meat inspection service submits for inspection a ham infested with mites, with the view of eliciting information as to control methods; a veterinarian in Texas invites discussion of a tapeworm from a goat; a commercial concern solicits information on dips.

The development of a new theory concerning the distribution of the tapeworm among poultry, the recommendation of gasoline in treating wounds infested by screw worms, experiments looking to the rearing of lambs to marketable age without loss from stomach worms, and the minimizing of losses from roundworms among young pigs, comprise recent contributions of the Zoological Division to the study of parasites. Field investigations in McLean County, Illinois, include observations of 3500 pigs on 20 farms where losses from roundworms are being reduced. The method employed is: Prior to farrowing time, loose litter is removed from the farrowing pens, the latter being given a scrubbing with boiling water and lye. Ten days before the sows are expected to farrow, their udders are cleaned and the sows placed in clean pens. Soon after farrowing the sows and pigs are given quarters in a clean pasture. Some portable sheds or houses, which follow the succulent pasturage, afford shelters for the sows and their offspring. The losses from roundworms when this method is followed are almost negligible.

1. A cork tree, showing the typical low trunk and free-spreading branches. 2. A corner of a sorting room in the cork warehouses of Seville. 3. Preparing the cork for carriage to the railroad

Before and after the cork harvest

Saving Uncle Sam's Pennies

The United States Bureau of Efficiency, and What It Is Doing to Conserve Federal Funds

By Herbert D. Brown, Chief of the Bureau

Abstracted from a paper read before the National Association of Manufacturers on September 13th, 1921

THERE have been efforts in the past to investigate the conduct of the business of our Government, but none of them have amounted to much save in the accumulation of data of value. The present Bureau of Efficiency began on March 4, 1913, as a division in the Civil Service Commission with an appropriation of $12,000 for the first year. It became an independent establishment on February 28, 1916, and this year it has an appropriation of $125,000. It is the only office of the Government created for the exclusive purpose of saving money; all others are engaged in spending it.

I had the honor of being connected with two previous commissions of similar character. Having observed the efforts of these organizations to improve the departmental service, and having studied the reports prepared by the gifted men who were members of these organizations or employed by them, I came to the conclusion that they had fallen short of rendering the great services which might have been expected of them, because they had not perceived that only by personal investigation of the offices themselves, by tact and patience in dealing with the workers of those offices, and by absolute willingness to surrender all credit for their services, could their ends be attained. I believe that only by winning the good will and cooperation of the administrators and the employes in the offices in which the work is done is it possible to achieve permanent results.

First of all, the watchword of the work must be "cooperation, not coercion." No officer of the Government is happy to have an outsider come into his office and assume to dictate how many clerks he should have, and what he should pay them, and how they should do their work.

Secondly, as a part of the general policy of cooperation it was necessary to adopt the principle of "no publicity." It is dangerous to the success of our work even to make detailed reports about it to Congress, if these are to be published. A bureau chief is not likely to be much more amiable if the delinquencies of his office are described in an annual report than if they are described in a daily paper. It has, however, been no part of our policy to conceal our operations. Although our published reports are meager, there is no lack of typewritten reports in our office which contain full and detailed accounts of every change and recommendation for which the Bureau is responsible.

The third principle guiding the Bureau in its work is that it acts in an advisory rather than a supervisory capacity.

The fourth principle that seemed to me from the first fundamental in efficiency work was the substitution of what might be called laboratory tests for academic discussions. There has never been time nor inclination in the Bureau of Efficiency to write lengthy reports, but there is always time for careful experiments and prolonged tests of proposed operations. Our general practice has been to take a representative part of the work to our own office and experiment with it until we have devised what we believe to be better or more economical methods than those employed.

The next principle that I felt was important was that emphasis on "team work" might develop an esprit de corps in the Bureau that would offset in some measure the small salaries paid by the Government for this kind of work compared with the salaries paid by private firms.

Finally, as a sixth principle, it was clear to me that the Bureau must be absolutely and under all circumstances non-partisan. To an efficiency organization it should be a matter of indifference what party is in power. Good government should be the only interest.

Generally speaking, our Bureau does two classes of work. First, we handle problems specifically assigned to us by Congress, either by statute, by resolution of either House of Congress, or more or less informally by the various committees and individual members of Congress. Second, we assist heads of departments and bureaus in developing better methods and procedures for doing their work.

Congress has, from time to time, given us a wide variety of things to do. As a result of our recommendations, legislation was enacted at the last session of Congress abolishing the Subtreasuries. This recommendation alone resulted in saving nearly half a million dollars a year in administrative expenses and about $2,000,000 a year in interest on the Public Debt. We have installed a system of efficiency ratings for the employes in the Post Office Department. We are engaged at this time on a similar installation for several offices of the Treasury Department. We have made actuarial valuations of the cost of the various pension plans which from time to time were proposed for retiring superannuated employes. We have installed an accounting system in the Indian Service. For about three years we cooperated with the Bureau of Internal Revenue in solving the immense problems which confronted that Bureau in collecting the income and excess profits and other taxes. We submitted reports to the Budget Committee of Congress which had a material influence on the budgetary legislation which was adopted at the last session. We have concluded an investigation of the methods of the Civil Service Commission. We have about concluded our investigation of the statistical work of the Government. We shall submit proposals to Congress when it convenes in December for the reorganization of the executive branch of the Government needed to eliminate the duplications of work and overlappings of authority which now characterize the activities of many of the executive departments. This, in a general way, will give an idea of the kind of work which the Bureau of Efficiency has done and is now doing at the direct request of Congress.

BEFORE the United States went to war with Germany, the contribution of its average citizen to the maintenance of the general government was small, and was collected from him indirectly so that he scarcely realized that he was required to make the contribution. It followed that his interest in the operations of the Federal Government was languid. The war has changed all that. For the first time in his life the citizen has had to give and lend directly to the Government from his private store. The Government has slowly demobilized its fighting forces and still more slowly relinquished its control of problems of production, supply, transportation, and finance. But the heavy cost of government continues and the people are naturally asking why. They are wondering whether the heavy taxation is the result of wasteful mismanagement in the Government offices. Mr. Brown's bureau is answering this question, and we are glad to let Mr. Brown tell the story to our readers.—THE EDITOR.

The work which we do, however, at the request of heads of departments and bureaus is fully as important as that which we do at the request of Congress. The Bureau has worked in six departments and six independent establishments and up to this time has prepared and submitted about 70 separate reports. We have made 224 investigations, which we classify as follows: Office methods, 38; filing, indexing, 23; labor-saving devices, 17; cash accounting, 17; property accounting, 8; securities accounting, 1; cost accounting, 1; pay system, 5; auditing methods, 11; duplication of activities, 9; organization, 18; statistical, 10; actuarial, 3; employment methods, 2; efficiency ratings, pay standardization, 26; work records, 5; special investigations, 30.

I am pleased to record that most of the recommendations made in these reports have actually been adopted. I believe that our success is due largely to our adherence to the six principles noted above and adopted at the beginning of our work as fundamental.

While concentrating upon specific problems in the offices which it was directed or invited to enter, the Bureau of Efficiency has been working steadily at the larger problem of improving the administration of the Government as a whole.

The quality of administration in the Government service, as in any private business, must depend upon two factors: first, the character of the personnel employed and, second, the details of organization under which the personnel is required to do its work.

The personnel troubles of the executive departments are generally due to two conditions peculiar to Government employment. In the first place, the important administrative positions in the service are filled, ordinarily, by persons who make no claim to administrative or executive ability, persons selected primarily on grounds of political expediency; and, in the second place, the salaries of the technical and supervisory officials and employes are woefully inadequate. The second of these conditions, fortunately, is by far the more important as a factor contributing to inefficiency. I say fortunately because it is possible to correct that condition, whereas, so long as we maintain a party form of government, politics will continue to dictate the appointment of the few major executive officials of the Government. This is in fact desirable in order to avoid the possible development of a hard and fast, though of course highly efficient, bureaucracy not responsive to the will of the people.

The Bureau has made a study of salaries paid by State and municipal Governments and private establishments that will enable Congress to readjust salaries in the Government service on a scientific basis. Congress alone has power to act in this matter, and Congress is ready to act, I believe, provided it has honest, unbiased, complete and accurate information upon which to base its action. This information will be available in December, and I hope it will result in legislation which will make it possible for the Government to obtain and hold competent and efficient workers in those positions that carry the great burden of the Government service.

The second factor which contributes to the present ineffectiveness of the Government as a business establishment is found in the improper organization of the executive branch of the Government for effective service. We are all familiar, at least in a general way, with the defects of the present administrative machinery. We know, for example, that the Interior Department now has jurisdiction over a great number of bureaus of a miscellaneous character that have nothing to do with each other or with the functions which the Interior Department was originally established to perform. We know that many agencies have been located in the Treasury Department, the great fiscal department of the Government, which are purely non-fiscal in character, such as the Coast Guard, the Public Health Service, the Supervising Architect's Office, and the Bureau of War Risk Insurance. We know that the great bulk of the civil public works of the Government are executed under the supervision of the War Department, although the Bureau of Public Roads is located in the Department of Agriculture and the Reclamation Service in the Department of the Interior. We know, furthermore, of the independent existence outside the jurisdiction of any of the great executive departments, of some forty-odd boards, commissions, offices and bureaus which, practically speaking, do their work without any supervision whatsoever. These are merely examples of a condition that would require volumes to describe fully, but is generally understood.

This also is a condition which the departments themselves are practically without power to remedy. The present details of organization have been prescribed by Congress, and only Congress can take action to effect a proper alinement of the agencies of the Government and a proper distribution of work among those agencies. On this matter also Congress is, I believe, ready to act, and here again the Bureau of Efficiency has been asked to aid in the collection of the information upon which intelligent action can be taken. We shall submit in December a plan for the regrouping of services according to the nature of the work performed. Our theory is that all services operating in the same field should by law be placed under one general executive direction, and that, conversely, the field of action of each executive department should, so far as possible, be restricted to a single class of closely related activities. As an illustration of the application of this theory, all the great public works establishments of the Government, including river and harbor work, the construction and maintenance of public buildings and grounds, the Reclamation Service, the construction and maintenance of publ'c roads, the development of inland waterways and

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Blast Furnace Slag

What It Is, and How It May Be Used as a Building Material

By Richard Gruen*

BLAST furnace slag is a product of the blast furnace in the manufacture of iron and is formed by the chemical combination of the gange material or the earthy constituents of the iron ore and the limestone or dolomite flux added to the furnace charge. It floats on top of the molten iron in the lower part of the furnace and protects the same from being reoxidized by the hot air blast that blows through the furnace. When the furnace is tapped, the molten iron and slag are separated, the slag flowing in one direction into large ladles on flat cars, while the iron is permitted to flow into pig iron molds. The hot slag is dumped out of the ladles at a suitable part of the plant and allowed to cool in a pile. Then it is either processed in some way or else used or sold as such to fill in ground.

A distinction is made between two kinds of slag, acid slag which can be drawn out into a string just like honey when it is molten, and basic slag, which does not possess such a degree of internal cohesion, but which breaks off short when drawn out in this manner. The first kind of slag contains much silica while the latter kind contains considerable lime.

The slag that is dumped out of the ladles in the hot state and allowed to cool off on the ground has an appearance much like that of the volcanic rock basalt and is called lump slag. Many slags of this nature, in which the individual pieces are not large, crumble away to a fine dust after several hours' or weeks' exposure to the air, due to the crystallization processes which take place within the lumps.

If there is a plentiful supply of water, then the slag can be run into a large vessel containing a great excess of water and the slag sand which is obtained in this way can be sifted to remove the large particles. The conversion of the slag into furnace sand is called granulation.

Slag is a lime alumina silicate, in which the proportions of lime, alumina and silica vary according to the iron ore that is smelted. There is a little magnesia present as well, and when spiegel iron is made, the slag contains manganese.

Each individual slag has its particular uses, dependent on its properties which are a function of its chemical composition. For example, the slags which contain large amounts of manganese and which were originally thrown away are now used in the manufacture of ferro-manganese. Many slags are suitable for the making of glass. Only a small amount of alkali and silica need be added. It is strange to say that in spite of the ease with which this can be done there is no mention made of the same in the literature and it has not come to the writer's knowledge that any glass plant has used slag for this purpose. Slag has also been used in mining work, especially in coal mining, to fill up the cavities made in the earth after the coal has been removed. Lump slag and slag sand have both been used for this purpose, being mixed with water in regular cement mixers on the spot. The granulated slag gives the better results.

At the present time, slag is being used more and more as a construction material in building houses and other structures. Sand slag has been used with considerable success in road making. It forms a hard, firm surface due to the property that it has of hardening in the air.

Lump slag has been used for some time in the past in the manufacture of paving stones. These stones are roughly formed from cast slag blocks that are cooled very gradually, whereby the slag is given a tempering action, and is then not so apt to crack. The difficult part is to separate that slag which has a tendency to fall to pieces on exposure to air. A mere chemical analysis does not afford sufficient information to tell which slags are subject to this action, and neither does a microscopical examination yield the necessary information. It has been proven by experience that the surest way in which to tell which slags are unsuited for making paving stones, because of their tendency to fall to pieces on exposure to the air, is to have the expert blast operator examine the slag and abide by his decision. He can tell from its external appearance whether or not the slag possesses the proper stability to be used for this purpose.

Blast furnace slag is an hydraulic cement, that is, it becomes hard and stone-like from the interior outward in air and under water. This fact has been known for a long time. The reason for this property can be seen readily from an examination of the composition of blast furnace slag and that of ordinary portland cement. The former contains the same oxides in composition in about the same proportions as they are found in cement. Therefore it is not strange that it exhibits the same properties.

In spite of the fact that this knowledge has been common property for quite a long time, the use of slag on a large scale for this purpose has not had a very rapid development. The scientific principles underlying its use have been evolved very slowly due to the difficulties encountered in investigation work of this nature and as a result thereof, the use of slag in the manufacture of cement was retarded considerably. The first experiments were made in an attempt to make a cement by adding lime to molten slag and mixing the two together. This was naturally unsuccessful, as it did not take into consideration the fact that in the making of cement the raw materials had to be heated to a high temperature. When this sort of experimentation was abandoned and the slag was cooled and then ground up, it was found that the ground slag, which gave a good cement today, refused to set the next day. Patient experimentation revealed the fact that the reason for this phenomenon lay in the physical condition of the slag, and it was found

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*Zeitschrift f. angew. Chem., 1921, 101-102.

Our Latest Science—Eugenics

Its More Important Findings and Its Bearing Upon the Future of the Race

By Albert A. Hopkins

A NEW science seems almost impossible, yet it is brought home to us that the science of eugenics as developed by Darwin, and more especially by Sir Francis Galton, has come to stay and take its place with the more exact sciences. A message of hope has been brought to this country by the delegates to the Second International Congress of Eugenics which has just been held in New York in the "Hall of Man" at the American Museum of Natural History. Major Leonard Darwin, the illustrious son of an illustrious father and near kinsman of Sir Francis Galton, made the initial speech. He emphasized the impossibility of attempting to regulate human mating by legislation and deplored the popular misconception of eugenics which credited that science with a design to abolish romance, and to introduce "cattle-breeding" principles into the domestic affairs of human families. On the other hand, love marriages were extolled as natural eugenics. Marriages for money and other advantages were denounced as "dysgenic," which means as tending to the deterioration of the race, instead of the improvement.

The tracing of heredity backward from son to father, with the help of the knowledge of eugenics, was discussed by Dr. Charles B. Davenport, who said:

"Our knowledge of the inheritance of physical traits is sufficiently precise to be applied practically to cases of doubtful parentage. If the child, the known mother and both of the putative fathers can be seen and some inquiry be made as to family stock of the three adults, a decision can generally be rendered with a high degree of certainty, ranging from 75 to 90 per cent. For, usually, there will be not one critical trait merely, but several traits, whose combined evidence will be overwhelming. Already the Eugenics Record Office has been asked to answer certain questions about the inheritance of traits in a case of a claimant who maintained that he was the son of a wealthy man who died without known heirs. As lawyers get used to the idea, eugenical knowledge will be more and more called upon."

The romances which eugenics has already actually blighted or fostered in cases in which intended unions were submitted to the analysis of eugenic experts at Cold Spring Harbor, were discussed as follows: "There will come a realization of the importance of heredity in marriage matings. Young persons to whom marriage is so serious a matter will be led to stop and consider when they feel they are falling in love, and inquire concerning consequences to offspring. Already there is being developed a well-defined conscience in the matters of cousin marriages and of matings into families with grossly defective members."

All the speakers took rather pessimistic views of the future of the human race because of the threat of race degeneration in the breeding out of the best stocks and the rapid increase of the poorer strains. The "melting pot" theory is a complete fallacy, according to eugenics, because it suggests that impurities and baser qualities are eliminated by the intermingling of races, whereas they are as likely to be increased. The various speakers who dwelt on the subject were all on one side, holding that the mixture of poor stock with a good one does as much harm to the good stock as it does benefit to the poor. The theory held by some eminent anthropologists that all races have an equal capacity for development and that all race questions, even the negro question, are to be solved in the long run by race mixture, was vigorously combatted. Denying that certain race stocks are poor because of poor environment in the old world, the eugenists averred that education and better economic conditions in this country could only imperfectly overcome ingrained racial and family defects.

One of the strongest talks on the subject was by Professor Henry Fairfield Osborn, President of the Congress. "In the United States," he said, "we are slowly awaking to the consciousness that education and environment do not fundamentally alter racial values. We are engaged in a serious struggle to maintain our historic republican institutions through barring the entrance of those who are unfit to share the duties and responsibilities of our well-founded Government. The true spirit of American democracy, that all men are born with equal rights and duties, has been confused with the political sophistry that all men are born with equal character and ability to govern themselves and others."

Professor Osborn said that 500,000 years of evolution had impressed certain characteristics on the three great racial branches—the Caucasian, the Mongolian and the Negroid, and their variations. He said there was no form of matter so stable as the germ plasm on which heredity depends, and that this accounted for the stubborn permanence to types and of the survival of their original qualities in admixtures.

"In the matter of racial virtues," he said, "my opinion is that from biological principles there is little promise in the melting pot theory. Put three races together, and you are as likely to unite the vices of all three as the virtues.

"For the world's work, however," he said, "give me a pure-blooded negro, a pure-blooded Mongol, a pure-blooded Slav, a pure-blooded Nordic and ascertain through observation and experiment what each race is best fitted to accomplish in the world's economy."

The closing decades of the nineteenth century and the opening decades of the twentieth have witnessed what may be called a rampant individualism—not only in art and literature, but in all our social institutions—an individualism which threatens the very existence of the family; this is the motto of individualism, let each individual enjoy his own rights and privileges—for tomorrow the race dies. In New England a century has witnessed the passage of a many-child family to a one-child family. The purest New England stock is not

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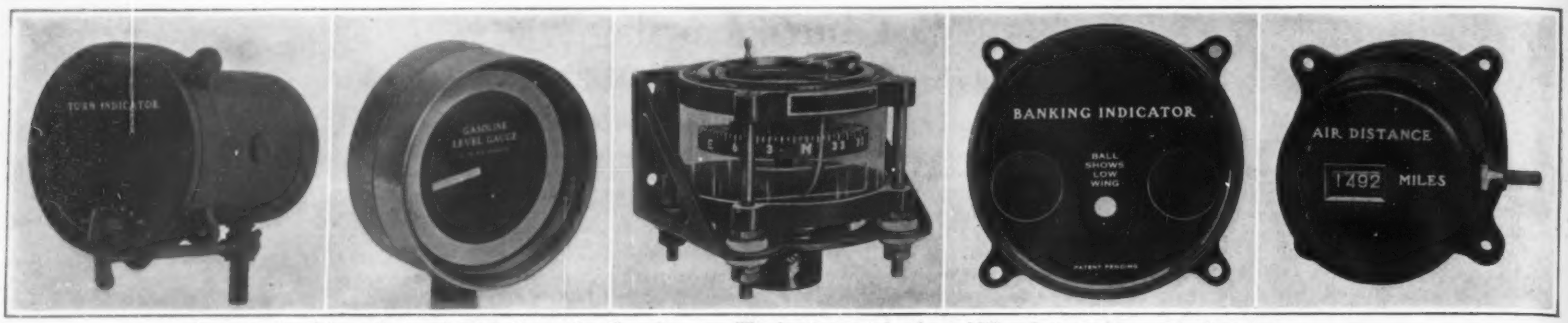


Some of the things that make aviation safer than it was. The instrument in the middle, that carries no signboard, is a compass

The Aviator's Tell-Tales

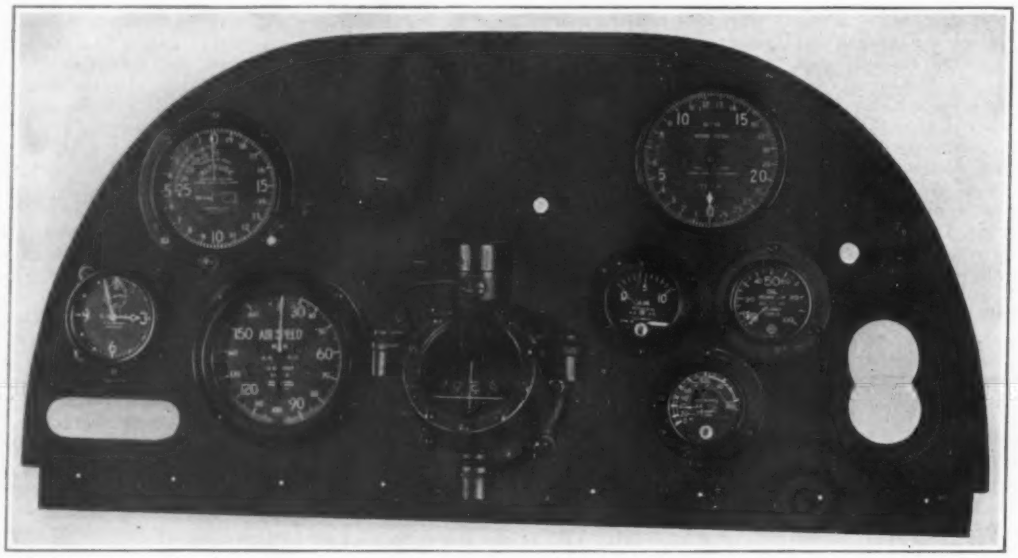
How the Pilot Keeps Track of Distances and Speeds, and Stays in the Air On an Even Keel

By William R. Andrews

IN marveling at the performances of daring aviators how many people realize that the achievements of these men would be impossible without the dependable pilotage instruments which represent the labor of inventive genius covering long periods of field experiment and laboratory research?

A number of factors enter simultaneously into the guidance of an airplane. The aviator must always bear in mind many things at once. He wants to know how high he is flying. But at the same time he naturally needs to know how fast he is going. And in maintaining speed how is the airplane performing? Is it moving through space inclined to the right or the left, like a ship that rolls over to one side in a heavy sea? Is the plane keeping its set course? Is each propeller running at the same speed as its neighbor? The fuel tank demands a vigilant eye; how long will the gasoline last at the present rate of consumption? Close observation of the temperature of the whole power plant is also necessary. Of course on every journey there must be an accurate timepiece. Furthermore, if the aviator intends to make a great ascent there is the oxygen apparatus, with its vital indicator upon whose precision so much depends.

The altimeter and the air-speed indicator would probably be the first of the instruments to catch the attention of the average man gazing for the first time at the instrument board of an airplane cockpit. The importance of the others as an essential part of the complete equipment would be temporarily lost sight of. The dullest imagination could not fail to respond to the significance of the self-explanatory words altimeter and air-speed indicator lettered prominently on the face of the instruments. In addition to their practical service they symbolize the romantic aspect of aviation—man's final entrance into the penetralia of great heights and his ability to fly through the air faster than the swiftest bird.

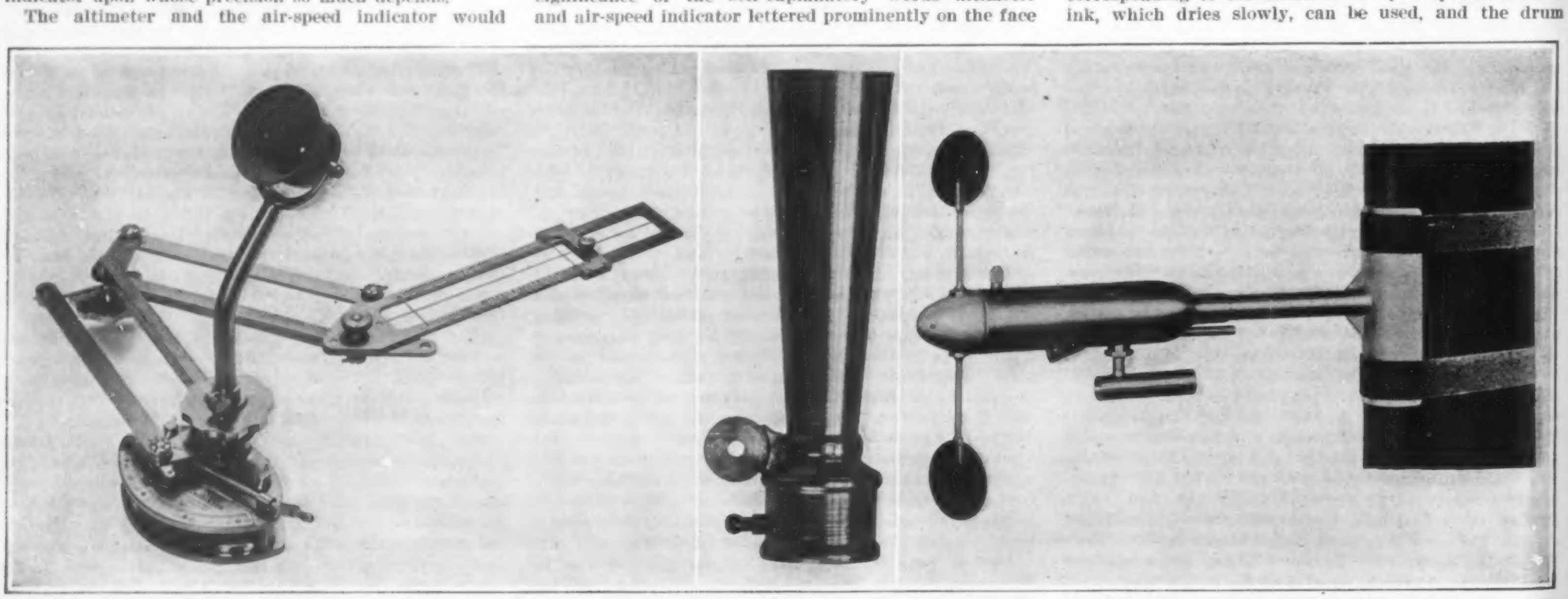


On this instrument board are shown the instruments in most general aeronautical use: Altimeter, clock, air-speed indicator, compass, tachometer, pressure gages and radiator thermometer

The preponderance of dials and the absence of switches and levers indicates that this instrument board belongs in an airplane, not in an automobile

The first of these outstanding instruments, the altimeter, is fundamentally an aneroid barometer. But in the operation of the mechanism the registration of barometric pressure is changed into a dial indication of feet, yards or meters above sea level. Altimeters must be made with exactness, otherwise the vibration of a plane will joggle the pointer beyond all hope of anything like an accurate reading. The corrugated metal vacuum chamber governing the movement of the pointer must necessarily be very sensitive to variations in atmospheric pressure, for the tip of the pointer must move one inch on the dial when the box, from which the air has been removed, expands even so slightly as 0.002 or 0.003 of an inch.

An altimeter is called a barograph when it records the gradations of ascent in a permanent form. On this type of instrument is a revolving drum to which a chart is attached and a pen describes certain curves corresponding to the altitude. Only a special kind of ink, which dries slowly, can be used, and the drum



Left: The device that indicates drift and ground-speed. *Center:* The venturi tube that helps to measure the gross air-speed. *Right:* The aviator's milometer, that measures the number of air-miles covered

More intimate views of the instruments upon which the aviator's course depends

moves by clock work. As the barograph would get out of order from the heavy jolting inseparable from the starting and landing of an airplane, the instrument is held in place in the cockpit by elastic cords. These absorb the shock and prevent any disarrangement of the suspended mechanism or any premature chart marks by the pen. The barograph is used in place of the altimeter only in test flights for the purpose of making official height records.

The instrument used to determine the speed of an airplane consists of two parts—the indicator proper and a pressure head, generally a kind of tube arrangement, which will be described later. The indicator is fixed on the dashboard and its function is the measurement of the differential pressure caused by the air rushing through the tube, which, in turn, is mounted to a strut, or wing brace. This pressure head usually consists of a combination of a pitot and a venturi tube. The first consists of two concentric pieces of tubing, with one end set squarely upstream to the air flow. A series of very small holes runs the length of the inside tubing. The space between the two concentrics is sealed at the end of the tube so that when the air enters the wind finds access only through the perforations of the inner concentric. This arrangement produces a suction effect on the outer tube and pressure on the one inside. The difference in pressure is then measured by a gage and the result is shown on the indicator in the cockpit. In some makes of air-speed indicators only the pitot tube is used.

The venturi tube, now so generally combined with the pitot, as mentioned above, is short, flares out at both ends and is constricted between the two openings. The pitot tube, long and narrow, on the other hand, has no variation in its diameter. An idea of the shape of the venturi becomes obvious by comparing it with an old-fashion blunderbuss, the kind that one associates with Stevenson's romances. A side tube meets the main tube at right angles at the point where the "blunderbuss" tube is the narrowest. Air passing through produces a suction effect in this side tube. As the velocity is greater at the constricted part of the main tube than at its mouth, there is considerable increase in the suction effect—in which consists the advantage of the venturi tube. The air-speed indicator is a stability instrument. By its aid the aviator is able to avoid the loss of flying speed and to keep on the safe side of excessive speed. The true speed is not shown and the aviator is obliged to make certain calculations to determine the distance being covered.

There is another instrument, however, which relieves him of this necessity and shows at a glance the number of miles traveled—the air distance recorder. On this the reading is simplified, as in the case of a pedometer used by a pedestrian or a distance indicator on an automobile. The distance indicator is operated by a rotating vane attached to a brace or wing support.

The venturi tube is used in another airplane instrument, the gyroscopic form of turn indicator, which shows any deviation from a straight line course. The air passing through the venturi tube furnishes the power for the operation of a small gyro, which spins about a lateral axis at about 7000 revolutions a minute. The well-known law of gyroscopic precession governs the operation of this type of turn indicator. When a gyroscope is affected by any motion, except motion on its own axis, it moves at right angles to the applied motion instead of in the direction of the applied motion. Bearing in mind this principle, one readily understands how the indicator works. As an airplane turns to the right or to the left the motion generated sets up a state of precession which, more intense than the motion caused by the veering of the airplane, is registered by the instrument dial. For the guidance of the aviator a white mark appears and he turns the rudder on that side to regulate his course.

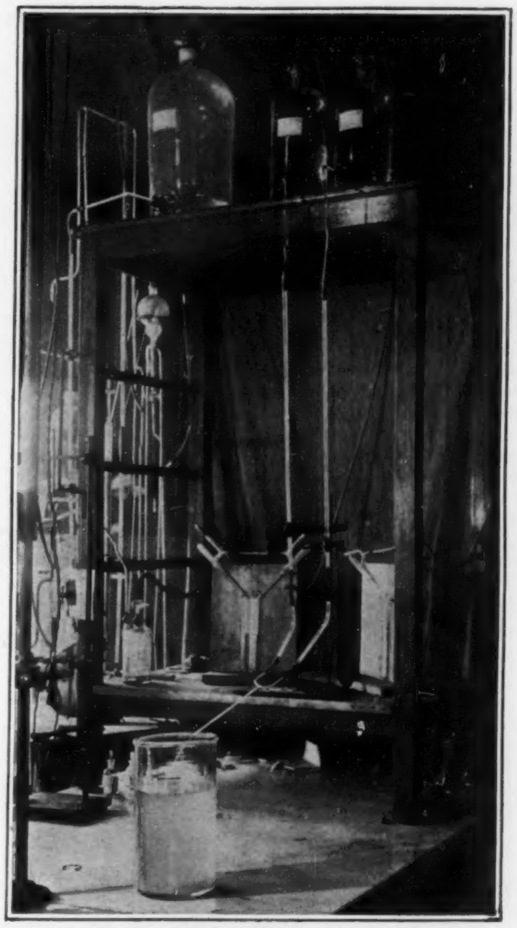
The operation of the other type of turn indicator is based on the measurement of differential pressure. In this connection a static head is fixed to each wing tip. This type, however, has disadvantages. Should the airplane strike a wide area of atmosphere also in a state of rotation, the instrument might read zero. But in the case of the gyroscopic types the absolute rotation is shown, and it measures the actual rate of turn.

Then there is the inclinometer, sometimes incorrectly called a banking indicator, which has a distinct function of its own. The tilt of an airplane, fore and aft, is shown by the inclinometer. There are two kinds. One is gyroscopic in principle, but the most common type consists of tubes filled with liquid and made to form a closed triangular circuit. The contents of the tube seek its level when the plane makes an upward climb. A scale shows the aviator the change in position undergone by the meniscus, the curved surface of the liquid column. This instrument is used only in test flights.

Banking indicators show how much an airplane rolls over on either side. There are also two kinds of these instruments. In the type which finds greater favor the familiar spirit level is modified to suit flight requirements. The other style operates by a pendulum, which is attached to a metal cross-piece on the face of the indicator.

In the upper part of some instruments white lines are to be seen which represent in the rough a transverse section of an airplane. When the machine turns on its side so that the right or the left wing tilts down—or "banks"—the pendulum actuates the metal bar, which forms an angle of greater or less degree with the small plane on the dial. The pilot knows that this condition of overbanking or underbanking has been corrected when by manipulation of the controls the metal bar and the miniature plane on the indicator become parallel. In another kind a white spot appearing at the crucial moment performs the function of the miniature indicating plane.

Connected with the vital part of an airplane, the motor, is the tachometer, which indicates the number of revolutions per minute of the propeller shaft. Thus correct engine speed may be obtained, which is particularly important when a plane is driven by more than one motor, as is now generally the case. Unlike some of the other instruments on an airplane, the tachometer is not a device specially designed to meet certain conditions in aviation. The aircraft tachometer is merely an adaptation of an instrument—operating on the centrifugal principle—which, for instance, has been in use for some time on twin screw steamships for the maintenance of the same speed in both propellers.



The Jolibois apparatus for rapid and accurate proportioning of liquid mixtures

While the centrifugal type is the most common in aviation, others have been tried out for airplanes. One kind has a clock work mechanism and counts the number of revolutions of the propeller shafts in a given interval of time. It is too sensitive to shocks, however, for practical use. In the case of those tried out during the war it was found that vibration from the big guns disarranged the delicate adjustment of parts necessary in the chronometric type. In the liquid type the angular acceleration—that is, the speeding up or slowing down rate of the propeller shaft—is indicated by a comparison of the fluctuations of two liquid columns in connection with a Bourdon gage. Other types are the elastic, the air pump, the magnetic and the air-viscosity, the latter being like a torsion viscosimeter, which records the rate of rotation of a fluid—in this case, air; as its viscosity is almost a constant, the change made by the dial is practically in proportion to the rate of rotation.

In the rate-of-climb indicator—used only in connection with laboratory and experimental work—the upward speed in feet per second is obtained by direct reading. A manometer—an instrument which measures the elastic pressure of gases and vapors—is part of this particular indicator.

An instrument for seaplanes skirting close to the surface of rivers and the sea is the night altitude indicator, optical in principle and built on the range-finder plan. However, it is not in general use.

The side-slip—a lateral movement of a plane caused by overbanking or by underbanking—is measured by the yaw indicator. Again the principle of operation is that of differential pressure. This is another instrument used only in experimental work.

Both the magnetic and the gyroscopic compass have been adapted to airplane use and at one time the long-period magnetic was used by many aviators as it performed the function of a turn indicator. In the gyroscopic form the actual turning rate is measured. For overcoming the constant vibration of a soaring plane a jeweled spring pivot of an adjustable nature and studs of rubber are used.

Then there are a number of thermometers and gages which show the condition of the various parts of the motive unit—the gasoline tank, system of lubrication and the radiator. As to the thermometers the type is that which depends upon the vapor pressure of a liquid in a bulb. Although they cannot be seen directly because of their location, the results of their operation are placed under the eyes of the observer in the cockpit by the aid of a long-distance Bourdon tube system.

In a general sense indicators for the gasoline tank may be classified as depth gages and flow meters. The former are constructed to indicate the contents-level by either a float, like that in a domestic water-flushing box, or by a contrivance which measures the hydrostatic pressure near the bottom of the supply tank. Built in accordance with the underlying principle of the venturi tube, flow meters reveal to the pilot at any instant just how much fuel has been consumed.

In respect to timepieces they are made with special consideration of the hard usage to which they are subject from sudden jarring in "taking off" and in landing.

A species of airplane equipment necessary in seeking high altitude records is the oxygen apparatus, without which the pilot could not live in the rarified atmosphere above us. While there are three types, chemical, liquid and compressed oxygen, only the latter has been used in America. In this kind the flow of oxygen is controlled automatically for supplying the exact amount

(*Continued on page 279*)

Mixing Liquids by Machine

By Jacques Boyer

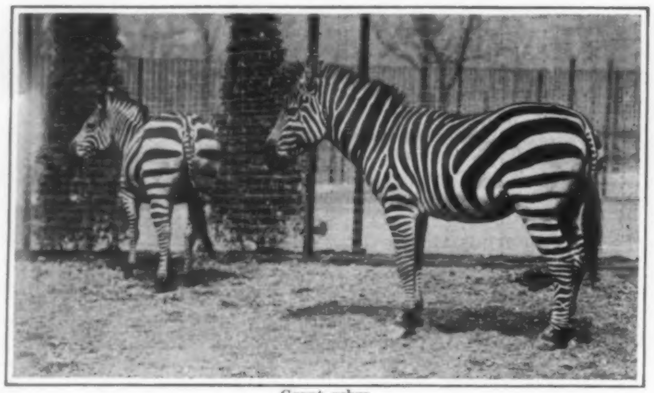
IN the laboratory certain difficulties are met in effecting the quick and homogeneous mixing of two liquids. M. Pierre Jolibois, professor of chemistry at the Polytechnic School, Paris, has invented a very simple apparatus for this purpose. The principle upon which it is based consists in directing, through the two branches of a Y-shaped glass tube, the two liquids which mix with each other in the end tube.

By means of faucets, the flow is regulated in order to obtain each liquid in the desired proportion in the resultant mixture.

In order to measure the flow, the admission of air in the vials which contain them, is effected through a graded venturi tube. By selecting a rapid colored reaction it is possible to ascertain the speed with which the two liquids mix. Let us put, for instance, in the left branch a solution of permanganate of potassium at 1.58 grams per liter; and in the right branch a solution of ferro-silver at 15 grams per liter and containing 50 cubic centimeters of concentrated sulfuric acid and 10 grams of sulfate of manganese per liter. The discoloration of the permanganate by this liquor is effected to the point of homogeneity in 0.04 to 1.2 seconds, according to the diameter of the tubes.

The liquid is sensibly homogeneous in those parts of the tube where it is colorless, and it is shown by this test that homogeneity is attained the sooner when the tube is thinnest. The method invented by M. Jolibois thus allows to operate very quickly, and by changing the form of the branches of the Y tube he has even been able to obtain the homogeneous mixture of two miscible liquids in the one-hundredth part of a second. This apparatus will be of great use to chemists for studying the speed of quick reactions between liquids.


Grevy zebra


Grant zebra


Mountain zebra

Three diverse species of the zebra to be found in New York Zoological Park

Zebras in New York

What the Metropolis Can Show in These Striped Creatures Which Are Less Docile than They Look

By William T. Hornaday

Illustrations by New York Zoological Society

WHEN Mother Nature finished making the first zebra, she must have smiled complacently, and taken pride unto herself on having done a fine job of wild animal painting. Even in her most joyous and sportive mood, it does not appear that she ever "laid herself out" more thoroughly in the decoration of quadrupeds than in her three species of zebra so long maintained for the millions to see at the New York Zoological Park.

Every zoological park manager perpetually is torn in spirit and harassed in mind by the rude hand of Death. All too frequently an animal of great rarity and beauty, that has been caught in a far distant wilderness and transported painfully and expensively over five or ten thousand miles of land and sea, at last reaches its Antelope House, or Ape House, only to lie down and die in its first ten days in its new home.

But zebras are different,—thank heaven! They have good appetites, good nerves and strong lungs; and they do not lie down and die, literally "at the drop of a hat." When they reach their zoo homes they gladly leave their boxes, they stretch their muscles, lie down and roll over, then cheerfully prepare to live long and enjoy life. A zebra nearly always gives his owner a good run for his money.

But really, it is astonishing to note how many distinguished African travelers traversed and criss-crossed the home ranches of the various zebras of Africa, for years and years, without noting or reporting the existence of several strongly marked species. For a period of fifty years or more the world was left to suppose that there was just one species of zebra, whereas the Grevy species is so remarkably different from all others that even a child could have noticed it, and recorded it. I will not be so cruel as to record here the names of the great and small travelers who penetrated, many times over, the home country of the Grevy zebra without having discovered its separate identity.

But at all events, the wonderful Grevy zebra, the largest, the most bizarre and the most striking in form and in color of all the zebra species never was recognized until 1882, when Jules Grevy was president of France. In that year King Menelik sent to President Grevy a living specimen, which, after being for a time confounded with the zebra of South Africa, finally was recognized as an entirely new species and was so described.

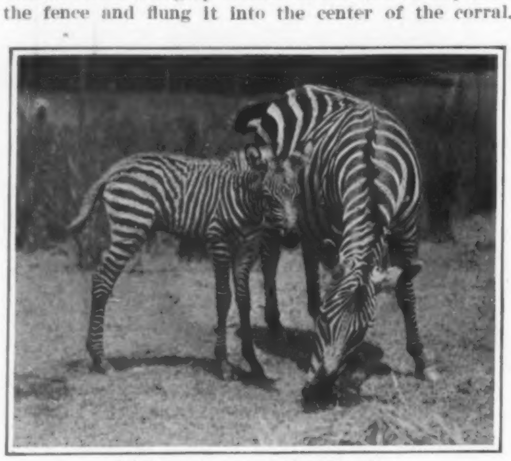
Moral: ***In those days Science was slow in sending out trained collectors; and this must not again occur!***

The Grevy zebra is recognizable at one glance by its complete coat of very narrow and intense black and white stripes, its large size and enormous ears. It is about one-fifth larger than the other zebra species. Briefly described, its home country is northeastern British East Africa and southern Abyssinia. This is the region midway between the great central lakes of Africa and the eastern sea coast. To find it in British East Africa it is necessary to go north to the Tana River and Mount Kenia. It is beyond the field of the average safari, and in collections of American sportsmen you see many Grant zebra heads, but few Grevy.

The two fine specimens of *Equus grevyi* now in New York have been in the Zoological Park for eleven years, and they are yet going strong. They are the star exhibits of the zebra and wild horse collection. Although theoretically they are "a pair," that relationship exists only upon paper. The male is so savage that we never have dared to quarter them in the same corral, even for one day. The male would either kill the female, or cause her death.

Once our official photographer, Mr. E. R. Sanborn, did for the Zoological Society a shrewd stunt. Knowing well the savage and dangerous character of the Grevy zebra stallion, he procured a keeper's uniform and with it made an excellent dummy keeper. This figure he firmly tied to the fence in the zebra's corral, set up his motion camera, and gave the signal to open the door.

The zebra rushed out to the middle of the yard, glared about him, saw the dummy keeper, and was fooled. With open mouth and a raucous scream he rushed for the doomed dummy-keeper, seized him by the head, bit him savagely, then grabbed him by the breast. With a mighty wrench he tore the dummy from the fence and flung it into the center of the corral.


Adult and young, Grant zebra

There he bit it, tore at its excelsior flesh, then knelt upon its chest and continued to tear at its alleged face with his teeth. The dummy was literally torn to pieces, and even on the screen it was a fearsome sight.

And when we saw it, we congratulated ourselves upon having had sufficient horse sense, in spite of all temptations, to keep that raging demon from the Grevy mare. The money value of a Grevy zebra is $2,000, but the exhibition value of an acclimatized and thoroughly settled adult speciment is all of $10,000.

There is now a well recognized group of zebra species known to naturalists as "the Burchell group." Its central and dominant figure is "the true Burchell" zebra, (*Equus burchelli*), with legs all white or nearly so. Around that type species stand, as so many subspecies, the Grant zebra, Chapman zebra, Crawshay's, Selous', and possibly others. The Burchell original is marked by its nearly-white legs, and by the fact that on the hindquarters, where the black and white stripes are widest, the broadest of the white stripes have a faint wash of dark color drawn along their centre line. These are known as "shadow stripes." They are well defined on the Chapman sub-species, but are not visible on the Grant.

The Grant zebra is very common in British East Africa, and also one of the most common in captivity. In the Zoological Park it breeds persistently and its colts mature well. If there is any young hoofed animal more handsome or more "fetching" than a Grant zebra colt, the world will be pleased to consider it.

We regret to say that on the Athi Plains in British East Africa, and in other places, the Grant zebra herds are to the struggling farmers a serious pest. The farmers say that no farm fence is sufficient to keep a herd of truculent and hungry zebras out of a field of grain. Even barbed wire does not stop them; and when a man has the nerve to try to do farming in the wilds of Africa, his claim for protection against spoliation by wild beasts is not to be ignored. The zebra herds are being treated as pests and the farmers of British East Africa are killing them down to reasonable limits, literally in self defense.

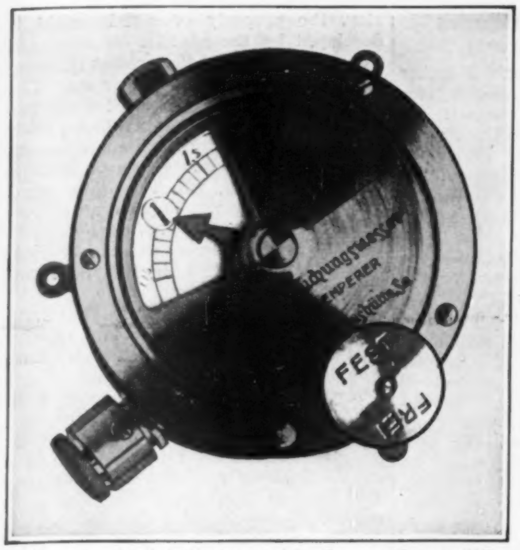
The Mountain zebra is the rarest species that ever comes into captivity. It is from the rough and mountainous regions of South Africa, and it is so nearly extinct that at the last report from its home country only about 400 had remained. By great good fortune, there is just one line by which this stock can be drawn upon for exhibition purposes, without in the least even threatening the extermination of the species. Each year one or two colts are caught, and by this means the Zoological Society expects to maintain its exhibit. The female specimen that for eleven years lived in New York died in 1918, but a new specimen is expected to arrive from Cape Colony soon.

Experiments with Pulp from Australian Hard Woods

EXPERIMENTS by the Forest Products Laboratory at Perth, West Australia, establish the fact that the pulps from mountain ash (Victoria), blackbutt, spotted gum, mountain gum (New South Wales), karri (West Australia), and silky oak (Queensland) are all suitable for paper making. While silky oak returned the most excellent results, the quantity of this timber is very limited.

The experiments indicate that these hardwood papers are much stronger in almost every respect than a series of imported good office envelope and bond papers taken at random from the laboratory stock. The specimen paper from pulp of mountain ash was found to be 1.2 pounds per thousandth inch stronger in bursting strength and considerably stronger in breaking strain than the choice imported papers.

Summarized, the report shows that: (1) The beating of hardwood pulps has a very marked effect upon the paper produced from them; (2) paper stock suitable for numerous uses is obtained by a proper beating treatment; (3) paper produced from the pulp of eucalyptus, after having received the prescribed beating, is equally as strong and in some cases stronger than good imported bond; (4) blending to give strength to the paper is not necessary, provided the pulp has received proper treatment prior to running over the machine; (5) in color, feel, and rattle these hardwood papers are similar to the bleached papers commonly used for stationery.



The wing-load indicator, with the needle at "1" indicating normal horizontal flight

Indicating the Safety Factor

THE pilot is limited in the freedom of maneuverability of the airplane above all by the danger zone; this is the strength limit of the airplane. To go beyond this limit is to break the weight-carrying members.

Until now air pilots have had no absolute guide whereby they could judge the different wing strains (stresses) in their approach toward the danger point or ultimate stress. They relied solely on their feeling. During flight the stresses of the plane fluctuate constantly. We recognize the existence of these fluctuations in stresses without exactly knowing their forces. However, the ultimate breaking stress of the weight-carrying members in airplanes is a known factor.

Therefrom arises the great usefulness of a device which will tell the pilot at any time during flight the extent of the stresses on the aerodynamic lift surfaces of his airplane through the air pressure force, and especially during extraordinary maneuvers. By means of such an instrument the pilot is enabled to tell at all times the degree of safety which exists between him and a possible wing break.

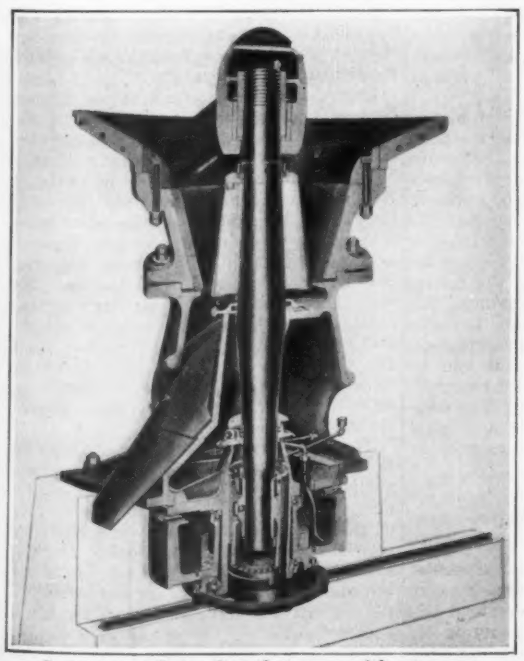
Such a device is the Klemperer wing-load indicator. As an invention and construction of a pilot this instrument embodies all the necessities for practical flight.

The wing-load indicator has a diameter of 2¾ inches; it weighs 10 ounces. It is just as simple to install this device as it is to install a clock. It is evident, therefore, that this device plays no role as far as the factors of space, weight, and installation are concerned.

This indicator is installed on the instrument board or on the fuselage, behind the windshield. It indicates how many times the wing load has risen or fallen above or below the straight horizontal "flight load" value. If the needle in the indicator points to "2," it shows that the weight-carrying members are carrying, on the average, twice the load had in normal flight. When the airplane has a safety factor of 5 and the indicator points to 2, then the pilot still has a good 2½ safety margin. At the moment when the indicator points to 5, then the pilot must expect the inevitable collapse of the aerodynamic lift surfaces.

When the plane is at rest on the ground in a horizontal position, the instrument points to 1, just as though it were in normal horizontal flight.

While starting and landing the instrument will indicate all landing gear ground bumps. In order to protect the instrument from any damage during the take off, it is equipped (like a compass) with a button which, with a simple turn, may *open* or *close* the instrument.



Gyratory rock-crusher that runs without gears

Flexible Hose for Loading at Sea

THE illustration depicts a new form of all-metal loading hose which has recently been put on the market by an eastern firm. Tankers taking on cargo in southern waters are often obliged to anchor some distance out at sea, due to inadequate docking facilities. Loading is then accomplished by laying a ten-inch pipe along the sea bottom to the point where the tanker is to load. At this point a heavy rubber hose long enough to come up over the side of the ship, is attached. When loading is finished the hose is dropped overboard and the spot marked by a buoy.

The life of this hose is comparatively short, being about six or seven months, also it requires constant attention. The cost of the new all-metal hose is a trifle more than twice as much per foot, but its life is measured in years. In fact, it is guaranteed for ten years. The weight per lineal foot is comparatively the same.

The metal hose is as flexible as, if not more so than, heavy rubber hose. With 120 feet of the hose one and one-half complete turns can be made. By reason of the ingenious locking device embodied in the design of these joints the line may be instantly disconnected at any part of its length. A special bronze having remarkable corrosion-resisting properties is used in the construction of these joints.

A Gearless Rock-Crusher

GEARS, which have always been an essential feature of gyratory rock-crushers, are eliminated in the machine pictured herewith, a highly developed secondary or re-crushing unit, designed to produce finely crushed rock at rapid speed and low cost. The absence of gears permits higher crushing speeds without adding mechanical complication to the machine.

This machine contains a ball-joint eccentric, which itself constitutes an important advance in crusher design, as it maintains better alinement of the main shaft than had been possible before. The machine has a highly arched spider, permitting the passage of any stone that will enter the machine. In addition to all this, the direct drive with all its advantages is now employed. The driving power is applied through a universal device that eliminates all friction and side strain, and relieves the grinding and side-thrust common to most gyratory crushers.

On test, one of these machines was driven for 36 hours at double its rated speed, and at the end of this test the eccentric had barely attained blood heat. The capacity, it should be noted, is well above that obtained with standard geared crushers.

Why the Sea is Salt

SEA water contains an enormous amount of mineral salts, no less than about 3.5 per cent. If the ocean were entirely evaporated the amount of salt left behind would be sufficient to cover the entire earth with a layer 60 metres deep. It used to be thought that the salt in the ocean was dissolved out of the rocks forming the continents by rain water and carried down to the sea by the rivers. But this theory is not tenable for various reasons. For one thing the salts contained in solution in the water of streams contain about 80 per cent of calcium carbonate and only 7 per cent of compounds containing chloride, whereas 89 per cent of the mineral compounds contained in ocean water consists of sea salt. Furthermore, when rivers are cut off so as to form landlocked lakes which afterwards dry out, the stratified layers of mineral salts which are formed differ in composition from sea salt.

Modern geologists, therefore, according to *Ciel et Terre* (Paris), consider the salinity of the ocean as an original instead of a derived condition. Suess has a theory that the mineral compounds found in the ocean water to-day proceed from the volcanic eruptions which took place in the early stages of the formation of our earth. Whenever such a volcanic eruption takes place in our own time water vapor, carbon dioxide, and gaseous compounds containing chlorine and sulphur are ejected into the atmosphere and are finally brought down to the ocean by means of rain. After each eruption of Vesuvius the crater is found to be covered with a gleaming white crust of sea salt; while the volcanoes of South America throw out enormous quantities of hydrochloric acid, the Puraci alone being estimated to eject 30,000 kg. of this compound. This volcanic activity is confined to only a few points upon the globe in our era, but it must have been very general in those primeval times before organic life existed upon the earth. It was then that the internal gases broke through the crust bringing with them the vast amount of chlorides which we find to-day in sea water.

Flexible all-metal hose for loading tankers at sea

A Use for Ohio River Mud

FARM mud has at last been put to a good and useful purpose. Mr. Louis Kuertz, a farmer of Cincinnati, has found that the mud on his place when mixed to a homogeneous mass makes excellent molds for garden lamps and benches. He takes the sticky mud and piles it up in odd fashion, holding it in place as he builds it up in the form of a mold with big rocks, stones and pieces of wood. In the case of forming the garden lamps an irregular core is left in the center by the chunks of mud as he piles it up and into this cavity he fills the liquid cement and gravel which, of course, takes on the form of the mold and sets. Garden benches are molded in the same fashion, usually in two sections, the top and bottom bench part.

To avoid the finished products being all of a gray cement color, coloring matter is sprayed on in a thin coat over all. No two lamps or benches are ever exactly alike, because of the nature of forming the mud molds.

A Cincinnati farmer makes ornamental use of the mud on his place

Some New Mechanical Amusement Devices

(Continued from page 269)

cars could never expect to accomplish.

Games of chance have been replaced almost entirely by games in which the skill of the several customers of the concession in question are matched. Typical of this is a game called the "Yacht Race." A number of tiny yachts are mounted on tracks, each in a separate glass case. These glass cases are mounted one above the other. At the front of the stand are several wind pumps, each connected with one of the yacht cases. At a given signal each customer starts to turn his pump and the resulting air pressure drives his yacht along from one end of the case to the other. The one who succeeds in pumping the most air gets his ship to the end first and wins the box of candy.

A combination of airplane and boating sensations is found in a nameless device which consists of a series of baskets mounted at the end of long spring arms. These are revolved by an electrical motor, an oscillating track at the center providing a bouncing motion. This bouncing motion is taken up and continued by the springs, so that the passenger not only is sailing through the air, but also going over waves, so far as his sensations are concerned.

People with strong constitutions and plenty of courage will find considerable pleasure ahead of them on the new pier. Those less courageous find equal enjoyment watching the other fellow try out the various devices.

A Centrifugal Concrete Mixer

(Continued from page 269)

producing concretes of like consistency or flowability, the strength of the two mixtures are not at such wide variance. The excessive mixing action of the new apparatus is advantageous insofar as it speeds the execution of the job.

Testing the Purity of Quinine

A CERTAIN corporation in Turkey had occasion during the war to determine the degree of effectiveness of the preparation of quinine coming from three different manufacturers. Owing to the primitive nature of the facilities at their disposal, it was impossible to make a chemical test with respect to the content of effective alkaloid. An ingenious way was found out of this difficulty by observing the mental effects produced by the drug.

The method of investigation was so planned as to include not merely the testing of the effectiveness of the quinine preparations but, as to investigate, likewise, the magnitude of the mental effect of the quinine when given in prophylactic doses, and the duration of the said influence. The conclusions reached were of significance with respect to the capacity for the performance of work of soldiers in active service. For example, one of the tests given was the capacity of perception of nine letters of the alphabet arranged in the form of a square behind the photographic slit, the shutter being left open from 1/10 to 1/100 of a second. For testing the capacity of attention and at the same time the degree of fatigue, the ordinary "crossing-out" test and also the Kraepelin counting diagram were employed. Testing the degree of deafness and the buzzing of the ears was done by means of a Galton pitch pipe and by whispering, and finally the sense of time was tested by requiring the subject to make beats at intervals of about half a minute.

All three of the preparations of quinine occasioned a slightly disturbed mental condition with an apparent increase in capacity for work done, but it was definitely proved that one of the three preparations of quinine available was considerably more energetic in its effect than the other two.

Saving Uncle Sam's Pennies

(Continued from page 272)

water power should be brought together in a new Department of Public Works.

The question is a natural one, will the work of the Bureau of Efficiency reduce the burden of taxation? My answer is "Yes." But, frankly, the reduction will be so small as to be imperceptible in the tax bill of the individual. I will explain why.

The total amount appropriated for the maintenance of the Government for the fiscal year 1921 (exclusive of the Postal Service, which is almost self-supporting, and exclusive of deficiencies on account of the fiscal year 1920), was $4,175,820,089. Of this amount $2,838,118,400, or about 68 per cent, was for the payment of obligations incurred on account of past wars, chiefly the recent war with Germany, such as compensation for death, disability, vocational training, hospital treatment, return of remains from France, pensions, interest on the public debt, sinking fund, and Federal operation of railroads. In addition the appropriations for national defense to cover the period from July 1, 1920, to June 30, 1921, were $855,956,963.

Now the sum of these two expenditures represents over 88 per cent of the money appropriated by Congress for the conduct of the public business during the fiscal year 1921, exclusive of the Postal Service and deficiencies on account of 1920. This means that less than 12 per cent ($481,-744,726) of that total of more than four billions is to be spent on the works of peace—that is, on paying for the development of commerce, agriculture, science, research, education, public health, and public works of one kind and another, salaries of the administrative officers and clerical assistants of the Government Departments and of the Federal courts and the salaries and expenses of the Congress itself. The Bureau's operations are confined to this 12 per cent. Amounts running into the millions are in themselves well worth saving, but it will be readily seen that the saving the Bureau can compass for the individual taxpayers will not be very noticeable.

I do not wish to minimize the importance of eliminating all waste in the civil establishments of the Government. I would do away with every scrap of duplication, every shadow of overlapping. I would reorganize the Departmental service in accordance with the best practices of modern business. I would have the people get full returns on every penny expended in running the Government offices. But what I want to be understood and understood clearly is that, whittle away as we may, our Bureau can only reduce the total public expenditures by perhaps a fraction of one per cent.

More than 88 per cent of the money spent by the Government during the next year will be on account of past and future wars. So long as we wish to maintain a military establishment of 300,000 officers and enlisted men, so long as we feel the necessity of building and maintaining a navy of the first rank, high taxes are inevitable. I am not discussing the merits of the military and naval programs. All I wish to say is that if we want to make really big reductions in appropriations, about the only place that that can be done is in the appropriations for our military and naval establishments. The decision as to whether this is desirable must be made by the people of the country as a whole.

Blast Furnace Slag

(Continued from page 273)

that only the slag which had a glassy appearance was suitable for making cement. Glassy slag is obtained by rapidly cooling and seems to retain its latent hydraulic properties, while slag which is cooled slowly does not possess the property of setting. Then it was established that in the case of granulated slag, the property of setting could be developed by the addition of a suitable amount of lime. At the present time slag cement contains about 15 per cent. lime and 85 per cent. of granulated slag. This mixture is burnt in rotary kilns, just as is done in the case of regular cement. Another variety of slag cement is called iron slag cement, which contains about 30 per cent. slag and 70 per cent. of portland cement clinker. This cement stands between regular cement and straight slag cement and is made by burning a mixture of slag and limestone.

The ordinary process of making building stones from slag is to mix together slag sand, lime and a little foundry sand. The binding action of the slag gives a stone which has a high mechanical resistance, about 100 to 200 kilograms per square cm. A method of causing the stones to harden quickly is to place them in the path of the exhaust gases from the internal combustion engines which drive the blast furnace blowers, and are rich in carbon dioxide and water vapor.

Light stone is made in the same manner as slag stone, with the exception that particularly light granulated slag is used as a filler, and as the binding material not just lime but a mixture of lime and ground slag, in other words slag cement, is used. This mixture is compressed in forms and attains a mechanical resistance in the stone of 10 to 25 kilograms per sq. cm. Both slag stone and light stone are very useful and economical building stones, the former as a substitute for ordinary brick and the latter instead of sand stone.

The author has experimented considerably in an attempt to transform the slag which is unsuited for these purposes into the kind that is suited. A very acid slag was treated with lime, while being heated, and then with lime and alumina again in order to obtain a slag which has a higher lime content. The melting of the slag was accomplished in an electric furnace. After many experiments it was possible, by putting it through this process, to make the acid slag capable of setting. The cement that was made with it possesses solidity and when both lime and alumina were added, the strength of the cement was increased over ten times that of the original value. The slag which was valueless beforehand was converted into a usable form in this way.

Our Latest Science

(Continued from page 273)

holding its own. The next stage is the no-child marriage and the extinction of the stock which laid the foundations of our republican institutions.

Professor Osborn, who was recently in Europe bringing together leaders in eugenics and biology from many European countries to attend the Congress, said that he had made a special study of parts of Belgium and France. Here he had been impressed, he said, with the manner in which the three main races of France, the Mediterranean, the Alpine and the Nordic, preserved their racial traits. He said that 12,000 years of similar environment and 1,000 years of similar education had caused only a slight divergence from the characteristics which were found in those races many thousands of years ago, as shown by evidences in the remains surviving from that period.

The difficulty in obtaining legislation to better the races, because of various prejudices and because of the fear on the part of politicians to give offense to any of their constituents, was emphasized by several speakers. Major Leonard Darwin said that it was very difficult to induce law-makers to pass laws for the benefit of the unborn who have no votes. Dr. Davenport said that the study of eugenics must progress until proofs of its contentions are piled high and have impressed the general community, before political action becomes a possibility. The exhibi-

tion of charts, photographs, paintings, books, etc., held in Forestry Hall is most interesting and will be open for a month. The meetings are not over as we go to press and more interesting papers may be looked for.

The Aviator's Tell-Tales

(*Continued from page 275*)

of gas needed at various stages of ascent to enable the aviator to breathe under normal condition. A curious fact in connection with this instrument is that there are only nine in existence in this country. That number had been made at the signing of the armistice, and the government countermanded the rest of the order in the hands of the manufacturer.

Drift indicators show the angle measurement when an airplane deviates from a set course caused by the action of cross winds. In one form of instrument readings may be obtained of the ground speed as well, and from heights of 500 to 20,000 feet. Broadly speaking, the operation consists of observing through an eyepiece on a vertical arm objects below which appear between two cross wires. Knowledge of the altitude, timing of the passage of an object from one wire to another, and the use of a table of figures give the speed in miles per hour. In reading the drift on the same instrument the pilot observes objects seeming to travel along a wire passing through the two cross wires and notes the results on a scale.

Soil Acidity

MR. W. H. MacINTIRE, of the University of Tennessee Agricultural Experiment Station, presents in the *Journal of the American Society of Agronomy* a very complete article on the nature of soil acidity.

No one phase of soil chemistry, the author says, has received more attention in recent years than the problem variously referred to as lime requirement, soil acidity, or lime absorption coefficient. The problem can hardly be considered, however, as having solely a chemical or physico-chemical basis in its relation to soil fertility, for it is closely correlated with, if not inseparable from, both bacteriological and plant physiological considerations.

The author summarizes in part: (1) Although salts of a number of organic acids have been isolated from soils, no one definite free organic acid has ever been extracted, as of record. (2) Certain salts produce a decrease of soil acidity (sodium nitrate, potassium nitrate, etc.), though in laboratory treatment during short periods followed by extractions, the reverse may be true. (3) Removal, or absorption, of dissolved bases by soils appeared to be a chemical function of acid silicates, principally alumino-silicates, the extent of whose hydration is a controlling factor in initial intensity and continuity of reaction. (4) The acidity of soils is, in the main, induced by the loss of calcic and magnesic inorganic salts, derived originally from the hydrolysis of the alkali-earth siliceous complexes, thereby increasing the acid properties or amount of acid silicates. (5) Silicic acid, in mass, will progressively hydrolize and continue to decompose calcium and magnesium carbonate when the liberated CO_2 is removed from solution. (6) After intense alkali treatments and the removal of excess of hydrates and after intense heating, pure silica, silicates, and titanium oxid will, on the addition of H_2O, hydrolyze and act towards the alkali-earth bases. (7) The injurious effect of acidity may be attributed, in some instances, to aluminum and other toxic salts, but, in general, more particularly to the diminished supply of available calcium from the depleted lime content of the soil, as influencing the adaptability of the media for biological development, and the meagerness of the lime as plant food, or as a regulatory component of the plant juice.

Starrett Adds Two New Radius and Fillet Gages to Line

Two new Starrett Fillet or Radius Gages, recently added to the Starrett line, are now being introduced by hardware dealers to the metal-working trades.

One of these gages, No. 272M, is generally similar to the well known No. 272 Starrett Fillet and Radius Gage, but is made in metric measure. Two sizes are furnished, Size A, having 18 leaves, from .75 to 5 mm., and Size B, with 16 leaves, ranging from 5.5 to 13 mm. As with No. 272 this gage will be found very useful for quickly obtaining the radii of fillets, corners, etc. It can be used in any position or at any angle, the formation of the gage allowing it to be used up to a shoulder, and for duplicating sample pieces. The studs holding the blades in place are eccentric with the round end of the case. This is of advantage since it causes the edge of the case to stand well away from the edge of the leaves when the case is opened.

Second of the two gages referred to in the first paragraph, is the New Starrett Fillet or Radius Gage No. 279. This gage is similar in general design to the Starrett Gage No. 272, except that it has twenty leaves with radii from .020 to .400 inch, inclusive. Nine of these leaves have concave and convex radii from .020 to .100, inclusive, by .010 inch, 4 leaves have concave and convex radii from .025 inch, one leaf with concave and convex radii of .250 inch, three leaves with concave radii only from .300 to .400, inclusive, by .050 inch, and three leaves with convex radii only from .300 to .400 by .050 inch.

Other details with illustrations of these Starrett gages are given in the new Starrett Catalog No. 22 "B". Copies of this catalog may be obtained on request from The L. S. Starrett Company, Athol, Mass.

The Diver from a Biological Point of View

THE physiological studies of the effects of various forms of athletic exercise, made by the French scientist, M. Alfred Thooris, have been attracting some attention abroad, and are well worth consideration on the part of our own college men and other athletes. One of his most recent reports concerns his observations of two divers, Pouliquen and de Lalyman.

As a result of the study of these two expert divers he concludes that a man immersed in water must render his respiratory apparatus immobile, in order to avoid the entrance of the water into his windpipe during the act of inspiration. As a matter of fact the thoracic tracing becomes practically a horizontal straight line during the submersion, resembling that made by a continuous vowel sound. But after the lapse of about thirty seconds a difference is observed in the tracings recording the movements of the chest, nose, and larynx. Three principal factors are noted here: The periodical expansion and contraction of the thorax, the singular mobility of the soft palate, and the free displacement of the larynx.

To sum the matter up, each period is characterized by the following phenomena—an initial inspiration with a blocking of the air passages by the soft palate; a rise of the larnyx accompanied by a synergetic construction of the glottis; an expiration emphasizing the descent of the larynx which is synergetic with the expansion of the glottis. During the inspiration communication with the outside air is completely interrupted, but during expiration there is such a communication in a fleeting and interrupted manner. During the act of expiration the diver comes out of the water. He then takes several rapid and short breaths (amplitude 7 mm. and frequently 8 in 20 seconds) before recovering his usual rhythm and the normal amplitude (22 mm.).

X-ray photographs showed an abrupt rising motion of the thyroid cartilage and a periodic expansion of the thorax.

M. Thooris finds from his observations and his personal experiments that the need to breathe while under the water does not become imperative until about 30 seconds have elapsed; at the end of this time the chest, isolated from the external air, goes through the same motions of expansion and contraction normal to it in the air. But these alternating motions can be accomplished in two ways only—either by *straining motions* (Mouvements d'effort) or by swallowing motions. But the former exhaust the diver, so that the latter are resorted to by experts.

A trained diver is capable of remaining several minutes under water and while this depends partly upon individual elasticity it also depends upon the manner in which the diver responds to the need of respiration which oppresses him. This need comprises three factors, according to M. Thooris, which in the order of their urgency are: The alternate need of expansion and of contraction of the thorax; the need of eliminating carbon-dioxide; the need of oxygen. The first of these is mechanical and depends upon the will, the second is chemical and automatic.

The biological process concerned in the act of diving consists of three phases: The act of inspiration with the closing of the soft palate; the rise of the larynx with synergetic construction of the glottis; expiration with fall of the larynx and expansion of the glottis and of the soft palate.

A practical result of these studies is found in the fact that the understanding thus gained of the physiological mechanism of the act of diving, greatly facilitates instruction in its technique. Finally, M. Thooris points out that the safety of all swimmers can be greatly enhanced by methodical training of the ability to remain under water.

Chinese Philosophy

Should old cars use heavier oil?

IN CHINA when roads get muddy the drivers put heavier wheels on their carts. The road is left to grow worse and worse.

In America when automobile engines begin to wear out, some motorists think it is time to change to heavier oil. The engine is left—to grow worse and worse.

For a time, heavier oil may partially restore compression and power. BUT it may not distribute to the bearings. BUT it may choke your combustion chambers with sticky carbon deposit. BUT some fine day your heavier oil may bring your car to a sharp stop for expensive repairs. Then you *are* in trouble.

Age does not alter the delivering capacity of your oil pump. It was designed specifically to distribute oil of a certain body—*and none heavier*. Your oil feeds don't grow larger as your engine grows older. They may not accommodate the "heavier" oil. At best, "heavier oil" acts only as a temporary stop-gap. At worst it starts new and far more serious troubles

No. Stick to the Chart on the right. Worn engines need repairs or renewals of parts. That is the only way to retain as long as possible the *original engine efficiency of your car.*

When used as specified in the Chart, Gargoyle Mobiloils give scientific lubrication. These oils prove their economy through providing greater lubrication; which means longer life, less renewal of parts, greater mileage per gallon of gasoline, greater mileage per gallon of oil, full compression and the greatest possible freedom from carbon troubles.

If your car is not listed in the partial chart shown here, consult the Chart of Recommendations at your dealer's, or send for booklet, "Correct Lubrication," which lists the correct grades for all automobiles, tractors and motorcycles.

GARGOYLE

Mobiloils

A grade for each type of motor

Chart of Recommendations

(Abbreviated Edition)

How to Read the Chart:

THE correct grades of Gargoyle Mobiloils for engine lubrication of both passenger and commercial cars are specified in the Chart below.

A means Gargoyle Mobiloil "A"
B means Gargoyle Mobiloil "B"
E means Gargoyle Mobiloil "E"
Arc means Gargoyle Mobiloil Arctic

Where different grades are recommended for summer and winter use, the winter recommendations should be followed during the entire period when freezing temperatures may be experienced.

The recommendations for prominent makes of engines used in many cars are listed separately for convenience.

The Chart of Recommendations is compiled by the Vacuum Oil Company's Board of Automotive Engineers, and represents our professional advice on correct automobile lubrication.

NAMES OF AUTOMOBILES AND MOTOR TRUCKS	1921		1920		1919		1918		1917	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
Allen	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
American Beauty	A	Arc	A	Arc						
Apperson (8 cyl.)	A	A	A	A	A	A	A	A	A	A
" All Other Models							A	A	Arc	Arc
Bell (York, Pa.)	A	Arc	Arc	Arc	Arc	Arc	Arc	Arc	A	Arc
Biddle			A	Arc	A	Arc	A	Arc	A	Arc
Brewster	B	A	B	A	B	A	B	A	B	A
Briscoe	A	Arc	A	Arc	A	Arc	A	Arc	A	[illegible]
Buick	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Cadillac	A	A	A	A	A	A	A	A	A	A
Chalmers	A	A	A	A	A	A	A	A	A	A
Chandler Six	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Chevrolet (8 cyl.)					A	A	A	A	A	A
" (Model 490)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" All Other Models	A	Arc	A	Arc	A	Arc	A	Arc		
Cleveland	A	Arc	A	Arc						
Collier	Arc	Arc	Arc	Arc	A	Arc	A	Arc	A	Arc
Crawford	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Cunningham	A	A	A	A	A	A	A	A	A	A
Dart (1 ton)			A	Arc	Arc	Arc	A	Arc		
" (1½ ton)	A	Arc								
" All Other Models	A	A	A	A	A	A	A	A	A	Arc
Davis	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Dodge Brothers	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Erie (Erie, Pa.)	A	A	A	A	Arc	Arc	Arc	Arc	Arc	Arc
Essex	A	Arc	A	Arc	A	Arc				
Ford	E	E	E	E	E	E	E	E	E	E
Franklin	A	A	A	A	A	A	A	A	A	A
Grant (6 cyl.)	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" (Com'l) (Model 12)					A	Arc				
" " All Other Mods.	Arc	Arc	Arc	Arc	Arc	Arc				
Hanson Six	Arc	Arc	Arc	Arc	Arc	Arc				
Harroun			A	Arc	A	Arc	A	Arc	A	Arc
Haynes (6 cyl.)	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" (12 cyl.)	A	A	A	A	A	A	A	A	A	A
Hollier (6 cyl.)			Arc	Arc	Arc	Arc	A	Arc	A	Arc
" (8 cyl.)					A	A	A	A	A	A
Holmes	A	A	B	A						
Hudson Super Six	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Hupmobile	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Hurlburt (3½ ton)	A	A	A	A	A	A	A	A	A	Arc
" (5 ton)	A	A	A	A	A	Arc	A	Arc	A	Arc
" All Other Models	A	A	A	Arc	A	Arc	A	Arc	A	Arc
Indiana (1 ton)					A	Arc	A	Arc	A	Arc
" (1½ ton)	A	Arc	A	Arc						
" (2 ton)	A	A	A	A	A	A	A	A	A	A
" (5 ton)	A	A	A	A	A	Arc	A	Arc	A	A
" All Other Models	A	A	A	A	A	A	A	Arc	A	Arc
Jones			Arc	Arc	Arc	Arc	Arc	Arc	A	Arc
Keystone	A	Arc	A	Arc	A	Arc				
Kissel Kar (12 cyl.)							A	A	A	A
" All Other Models	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
LaFayette (Indianapolis)	A	A	A	A						
Lexington (Continental Eng.)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Liberty	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Lincoln	A	A								
Locomobile	A	E	A	E	A	E	A	E	E	E
McFarlan	A	A	A	Arc	A	Arc	A	Arc	A	Arc
Madison (6 cyl.)					A	Arc	A	Arc	A	Arc
" (8 cyl.)									A	A
Maibohm	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Marmon	A	A	A	A	A	A	A	A	A	A
Maxwell	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Mercer	A	A	A	A	A	A	A	A	A	A
Mitchell	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
M. H. M.	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Nash	Arc	Arc	A	Arc	A	Arc	A	Arc		
" (Model 671)							A	A		
" (Commercial) (Quad)	A	A	A	A	A	A	A	A		
" (1 ton and 2 ton)	A	Arc	A	Arc	A	Arc	A	Arc		
National (6 cyl.)	A	A	A	A	Arc	Arc	Arc	Arc	Arc	Arc
" (12 cyl.)					A	A	A	A	A	A
Nelson	A	A	A	A	A	A	A	A	A	A
Noble	A	A	A	A	Arc	Arc	Arc	Arc	Arc	Arc
Noma	Arc	Arc	Arc	Arc	Arc	Arc				
Old Hickory	Arc	Arc	Arc	Arc	Arc	Arc	A	Arc	A	Arc
Oneida (5 ton)	A	A	A	A	A	Arc	Arc	Arc		
" All Other Models	A	A	A	A	Arc	Arc	Arc	Arc	Arc	Arc
Oshkosh	A	Arc	A	Arc	A	Arc				
Overland	A	Arc	A	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Packard	A	A	A	A	A	A	A	A	A	A
Parker	A	A	A	A	Arc	Arc				
Paterson	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Peerless (8 cyl.)	A	A	A	A	A	A	A	A	A	A
" All Other Models							Arc	Arc	Arc	Arc
Phianna	A	A	A	A	A	A	A	A	A	A
Pierce-Arrow	A	A	A	A	A	A	A	A	A	A
" " (Com'l) (5 ton)	A	A	A	A	A	A	Arc	Arc	Arc	Arc
" " " All Other Mods.	A	A	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Porter	A	Arc	A	Arc	A	Arc				
Premier	A	A	A	A	A	A	A	A	A	A
Rainier (1½ ton)	Arc	Arc	Arc	Arc	Arc	Arc				
" (3½ ton)	A	A								
" All Other Models	Arc	Arc	Arc	Arc	A	Arc	A	Arc	A	Arc
Reo	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
ReVere	A	A	A	A	A	A	A	Arc		
R & V Knight	B	A	B	A						
Sanford (5 ton)	A	A	Arc	Arc	Arc	Arc	A	A		
" All Other Models	Arc	Arc	Arc	Arc	Arc	Arc	A	A	A	Arc
Saxon	A	Arc	A	Arc	E	E	E	E	E	E
Seneca	A	Arc	A	Arc	A	Arc	Arc	Arc		
Signal (Model R)	A	A	A	A	A	A	Arc	Arc	Arc	Arc
" All Other Models	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Singer			A	A	A	A			A	A
Standard Commercial (Detroit)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Stearns-Knight	B	A	B	A	B	A	B	A	A	A
Stephens	A	A	A	A	A	A	A	A	Arc	Arc
Sterling	A	A	A	A	A	Arc	A	Arc	A	Arc
Studebaker	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Stutz	A	A	A	A	A	A	A	A	A	A
Templar	A	A	A	A	A	A	A	A		
Ward LaFrance	A	A	A	A	Arc	Arc				
White (16 valve)					A	A	A	A	A	A
" (3 and 5 ton)	A	A	A	A	A	A				
" All Other Models	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Willys-Knight	B	A	B	A	B	A	B	A	A	A
Willys Six					Arc	Arc	Arc	Arc	Arc	Arc
Wilson	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Winton	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc

Prominent Makes of Engines

	1921 Summer	1921 Winter	1920 Summer	1920 Winter	1919 Summer	1919 Winter	1918 Summer	1918 Winter	1917 Summer	1917 Winter
Beaver (Models J-JA-JB and JC)	A	A	A	A	A	A	A	A		
" All Other Models	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Buda (Models ATU-BTU-CTU-DTU-ETU-FTU-HU-HTU-IU-ITU-XU-XTU-YU-YTU)	A	A	A	A	A	A	A	A	A	A
Buda All Other Models	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Continental (Model B2)	A	A	A	A	A	A				
" (Model T)					A	Arc	A	Arc	A	Arc
" All Other Models	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Falls	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
G. B. & S. (Model AA)	A	A	A	A	A	A				
" All Other Models	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Herschell-Spillman (Models JU-S-V and VA)					A	A	A	A	A	A
" All Other Models	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Hinkley	A	A	A	A	A	A				
Lycoming	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Northway (Model 108)									Arc	Arc
" All Other Models	A	A	A	A	A	A	A	A	A	A
Rochester (Duesenberg)	A	A	A	A						
Waukesha (Models CU-DU-EU & FU)	A	A	A	A	A	A				
" All Other Models	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Weidely	A	A	A	A	A	A	A	A	A	A
Wisconsin (Models Q & QU)					A	Arc	A	Arc	A	Arc
" All Other Models	A	A	A	A	A	A	A	A	A	A

VACUUM OIL COMPANY

DOMESTIC BRANCHES: New York (Main Office) Philadelphia Detroit Minneapolis Des Moines Boston Pittsburgh Chicago Indianapolis Kansas City, Kan. Buffalo Dallas